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SAN FRANCISCO, CALIFORNIA

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CATALOGUE No. 3

HOISTING MACHINERY

BUILDERS OF

Risdon Water Wheels "Pelton Type"
Improved Bryan Roller Mills
Evans Hydraulic Elevators and
Hydraulic Mining Machinery
Ore Feeders, Rock Breakers
Mining Pumping and Hoisting Plants

PUBLISHED BY

The Risdon Iron Works

SAN FRANCISCO, CAL.

1897

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Risdon Iron and Locomotive Works

SAN FRANCISCO, CAL.

MANUFACTURERS OF IMPROVED

MINING MACHINERY

Adapted to Mining Operations of any Magnitude, and the Systematic Treatment of Gold, Silver, Copper, Lead and other ores, by any of the Popular Methods

Direct Acting Hoisting Engines
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Hydraulic Pumping Plants
Friction Hoisting Engines
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Rock Drilling Machinery
Geared Pumping Engines
Water Wheel Hoists
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Steam Pumps
Plunger Pumps
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Working Bobs
Balance Bobs
Air Compressors
Ventilating Machinery
Tramway Machinery
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Water Jacket Smelting Furnaces
Lead-Silver Smelting Works
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Steam Engines
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Steam Feed Pumps
Water Wheels
Power Transmission
Common Sense Whims
Johnston Concentrators
Risdon Concentrators

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Including High Pressure, Condensing, Compound, Tripple and Quadruple Expansion Engines; Steam Boilers of the Latest Designs, and other Machinery Equipments for Steam Vessels Designed and Built for all Kinds of Ocean, Harbor and River Service.

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For the Application of Steam Power, Hydraulics, Pneumatics, Electricity and for Manufacturing Purposes

EXCLUSIVE AGENTS AND MANUFACTURERS

For the Pacific Coast of Heine's Safety Boilers, Steel Whims, Bryan Mills Johnston Concentrators, Hoskin's Giants, Smith-Vaile Pumps

Hydraulic Riveted Sheet Steel and Iron Pipe a Specialty

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DONE IN SAN FRANCISCO AT PRINTING SHOP OF THE E. D. TAYLOR COMPANY, IN THE MONTH OF AUGUST AND YEAR EIGHTEEN HUNDRED AND NINETY-SEVEN.

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PREFACE.

This catalogue, No. 3, illustrates a few of the many styles of Hoisting Engines built by THE RISDON IRON WORKS, and which are the result of 35 years' experience in building engines for hoisting purposes. We have selected for illustration the styles most commonly used and which we recommend for ordinary work.

We build our engines with Corliss, D slide and poppet valves. The frames of box girder, flat and bored guide pattern. Cylinders single, simple, compound and triple expansion. Vertical or horizontal, geared or first motion. Drums single, double or multiple, straight or conical, spiral grooved or plain. For very heavy loads and slow speed we build double and compound geared engines. For fast work first motion engine for round or flat rope, the latter economizing space and weight. We also make our hoists sectional to pack over mountain trails. Our engines are built with cone or band friction, toe clutches on pinion or main shaft, and brakes of the post or band pattern.

Large engines entirely operated by steam, that is, separate engines for brakes, clutches, reversing gear and overwinding apparatus.

Our line of hoists comprises everything from the hand winch or Horse Whims to steam, gas, water, electric and compressed air.

Our trunk hoists are made for prospecting work as well as permanent equipment.

In writing give us all the particulars you can, as asked for on page 11 and we will cheerfully go into the matter, giving you the benefit of our experience.

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INTRODUCTION

A Few Words on Economical Hoisting Engines

The question of the proper installation for a mine is one on which there is a great difference of opinion.

The first deep mining in this country where large quantities of ore was hoisted was on the second line of shafts on the famous Comstock lode, and at that time geared engines were largely used. As depth was attained it was found that higher speed was necessary, and the question as to style of hoist was carefully gone into, with the result that flat rope first motion engines were used on the third line of shafts and gave excellent satisfaction.

The rapid sinking on the Lake Superior Copper Mines developed the round rope hoist, and today there is a great difference of opinion as to which is best. Our experience in hoists for deep mining has satisfied us that local conditions largely govern style. If large quantities of ore are to be hoisted from any one level the round rope hoist is very well suited to work of this kind. If the ore is to be hoisted from a number of levels so that changes in the position of cages are frequently required, the flat rope hoist has a great advantage.

Again, when large loads are to be started without counterbalance, the flat rope with its small centre and consequently great leverage will show marked economy in operating.

At Butte, Montana, flat rope is almost entirely used and gives good satisfaction.

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The flat rope engine can be set near the shaft, as the rope, always running in line with overhead sheaves, will not require the long lead that is necessary with drums. When round rope is used we advise that the overhead sheaves be placed on traversing shafts, thus keeping the rope nearer in line to coil on drum.

In very deep mining, when a number of compartments are used, it is well to have two engines, placed one behind the other, and the distances in shaft divided into two sections,—one engine to hoist all loads from bottom of mine half way up, making no stop to surface, the other engine handling all ore from the upper half. One of the principal mines in Butte, Montana, is now building a plant of this kind. We believe in placing self-loading and self-dumping skips in use in all large mines. In shafts having a pump compartment, it should be equipped with a hoist of the style described on page 47. For sinking shafts where it is necessary to hoist ore and not interfere with the regular work, we build special geared engines, as described on pages 21, 22, 23. They are all built in sections to go down shaft and can be operated by steam or compressed air.

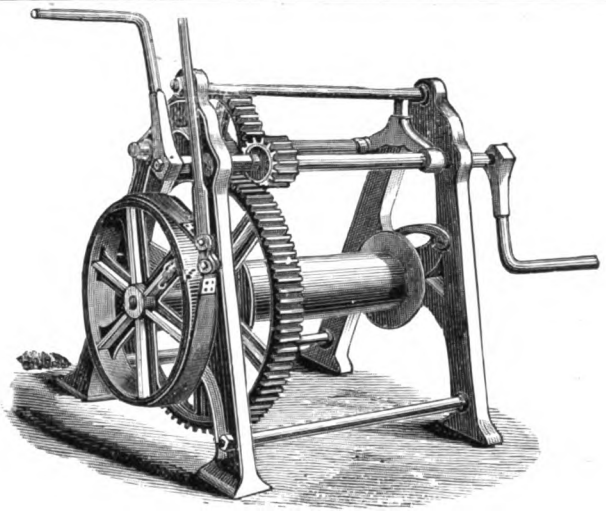
The use of plow steel rope we advocate, as its greater strength prevents accidents.

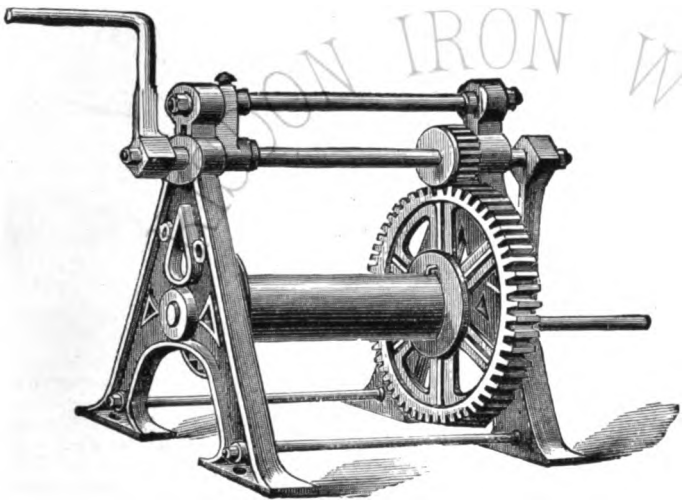
We build steel Gallows Frames which are largely used on high class plants.

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The... Risdon

SINGLE
AND
DOUBLE PURCHASE





Hand Winches, or Hoisting Crabs

SINGLE PURCHASE CRAB

No.	Tons Capacity with 2 and 3 Sheave Blocks.	WEIGHT. Lbs.	PRICE.
1	2	245	$ 50
2	3	315	60
3	4	400	75
4	5	515	80
5	6	650	90
6	9	800	100

DOUBLE PURCHASE CRAB

No.	Tons Capacity with 2 and 3 Sheave Blocks.	WEIGHT. Lbs.	PRICE.
10	4	400	$ 75
11	5	515	80
12	6	700	90
13	9	815	100
14	12	1050	125
15	15	1500	150
16	18	1750	175
17	24	2250	225

These Winches are constructed to lift load mentioned with 2 or 3 sheave pulley block.

The power is increased by the number of pulleys used in the blocks.

Sides are tied together by wrought iron stretcher rods witn solid collars inside of the frames and nuts outside.

The Barrel Shafts are of BEST WROUGHT IRON.

The Barrel, Brake Wheel and Ratchet are strongly made.

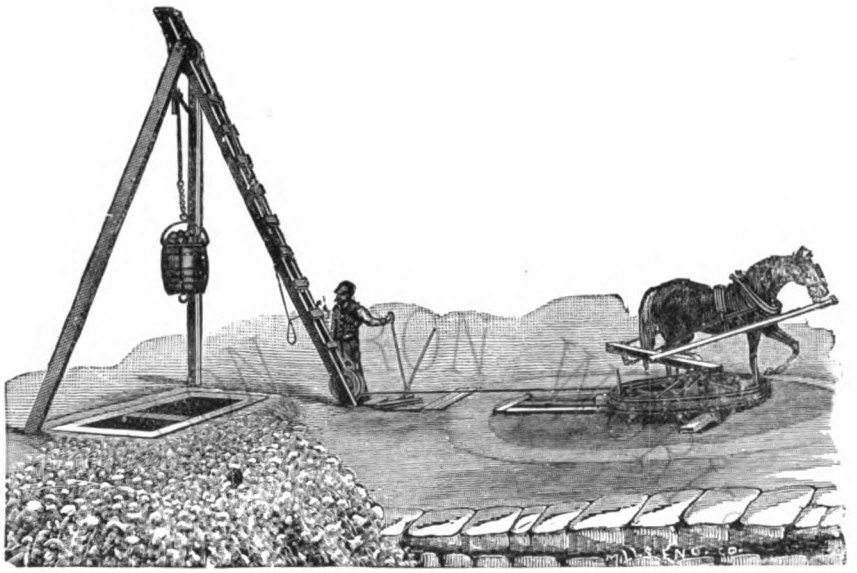
The Crank Shaft can be thrown out of gear, when lowering, with the brake, so the handle will not fly around.

The Double Purchase Winch is arranged with two speeds, and can be worked either single or double purchase. All Winches are equipped with Brakes.

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THE RISDON IRON WORKS' NEW.

Common-Sense Steel Whim.



DESCRIPTION.

Our Whim is all constructed of *iron* (except the sweep). The *castings* are all of *car-wheel iron*, and will stand *twice the jar* that ordinary castings will. The *wrought-iron arms* of the wheel are bolted to the hub and to the rim of the drum, and can be *taken to pieces for transportation* on *pack animals*. The rim is made of metal, with flanges to hold the rope on it. Our *one-horse Whim* has a drum six feet in diameter and will wind *500* feet of rope. The *levers for setting the brake* and throwing the sweep in and out of gear are of *wrought-iron*. The sweep is thrown up out of gear by forcing a wedge-shape piece of iron under the shaft; this gives great power, and when the horse gets the bucket *up to the sheave and won't stop*, it can be *thrown out of gear*, allowing the horse to go on around the circle, the *automatic grip* holding the load.

DURABILITY—We have had some of our machines *running six years without one dollar's worth of repairs* being put on them, and they are good for *twenty years* more.

STRENGTH—In our new steel Whim we have done away with about one-half of the castings used in our former Whim and substituted *wrought-iron* and *steel* for them. This brings the *chances of accidents* down to a minimum. Therefore, we have in our new steel Whim used just as little castings as possible, the two sheave wheels weigh nearly as much as all the rest of the castings used in each Whim. Our *one-horse Whim* will *raise the weight of an oil barrel filled with horseshoes*, and is calculated to *work year in and year out*, raising an *oil bucket filled with quartz rock*, considered to hold *five hundred pounds*.

DRAFT—We have the *lightest running Whim made*, less than one pound pressure on the end of the sweep will turn the empty drum wheel when no rope or brake is attached. When the kingpost is bolted down put the drum wheel on, give it a whirl and it will run around five or six times without stopping.

SPEED—The *speed at which we can hoist* is, with an ordinary gaited horse, about *80 feet per minute. A day's work of ten hours* is about *100 buckets* from a depth of 300 feet. A horse has a three to one leverage; a 200-pound pull on the single-tree will raise a 600-pound loaded bucket.

THE WEIGHT—Of the machine is an average of 850 pounds. It can be *packed anywhere a jack can go*, and can be taken to pieces in twenty minutes for that purpose. The *heaviest piece weighs 100 pounds*. Two men can load it on a wagon from off the ground. The drum wheel set up weighs 250 pounds.

CONCLUSION—The Whim which we have placed upon the market can be handled and is as *reliable as an engine*. It has a *ribbon brake*, similar to an engine, and a bucket can be dumped and lowered just as quickly and safely as with an engine. The *sweep can be thrown out or in gear when the horse is in motion, and the bucket will not run back into the mine*, always being held by the automatic self-setting grip.

PRICES AT OUR WORKS IN SAN FRANCISCO.

Whim	$150 00
Ore Barrels "Steel" 500 lbs. capacity	25 00
Norway Hooks	8 00
Gallows Frame and Foundation Timbers	30 00
Best Steel Cable	15 cts. per foot

WHAT IS INCLUDED IN WHIM.

Machinery in the **whim** consists or **drum wheel, sweep, lead pole, levers** for throwing in and out of gear and setting the brake, **brake strap** and all **connecting rods** and **bars, cable grip, sheave wheels** and **bearings.**

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INSTRUCTIONS FOR ERECTING COMMON SENSE STEEL WHIMS

Set the lower sheave and levers as near the shaft as convenient. Distance from edge of the shaft to the sheave leg of the tripod, should be six feet; distance from the center of the lower sheave to the center of the drum wheel, fourteen feet.

Now to grade out for the Whim, measure four feet from the edge of the shaft, on the side you want to set the Whim, and drive down a peg; *this can be on either side or end*—it makes no difference. The inclination of the shaft will make no difference. If it inclines you will have to put in a roller to keep the rope from rubbing on the rocks. After driving the peg at the sheave wheel, measure off fourteen feet in the same direction and drive another peg; this is for the center of the drum.

Now measure nine feet on your tape line or string, fasten one end to the last peg driven and draw a circle around this peg, which will be the distance the eye-bolt in the end of the sweep is from the center of the drum.

Grade your ground down as near level as you can.

Set the top of the mud-sills about four inches below the surface of the ground, if you can, or else fill up the track that much. Also study the cut of the ground plan.

To make the tripod you will need two pieces of timber 4x6 in. x 18 feet, and two pieces 3x6 in. x 20 feet. Place the sheaves as shown in cut No. 2, with upper one over the shaft and the lower one braced against the mud-sills, if convenient, but it makes no difference. The sheave leg may set away from the lever stand several feet on either side to suit the circumstances and convenience of the ground.

The mud-sills are each 6x6 in. x 16 feet long, the cross sill 6x6 in. x 8 feet long. Round timbers answer for this purpose where square ones cannot be had.

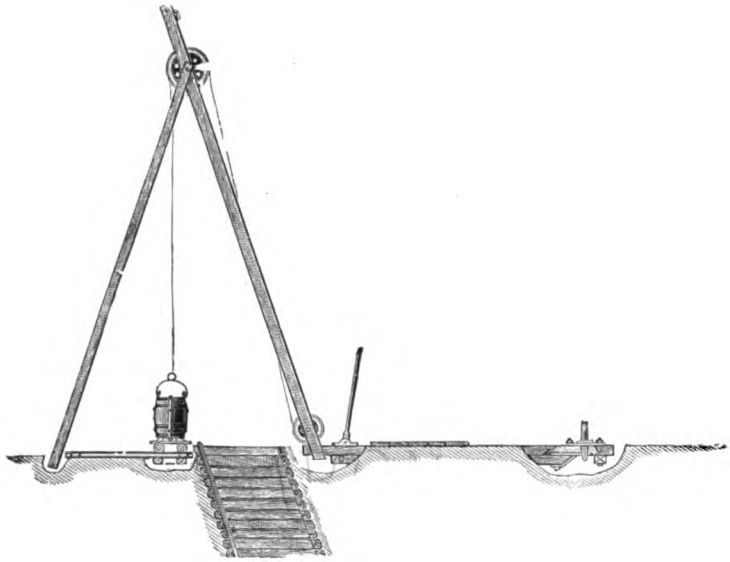
The piece in front of the sheave leg is 2x8 in. by 3 feet long and spiked to the mud-sills to hold them together.

The size of building that is best adapted for our Whim is 30x45 feet, the ground plan of which is shown in cut No. 2.

The smallest sized building or underground excavation the Whim could be worked in would be 20x27 feet. Of course if it was an excavation, the end of the chamber where the Whim was set could be in a circle.

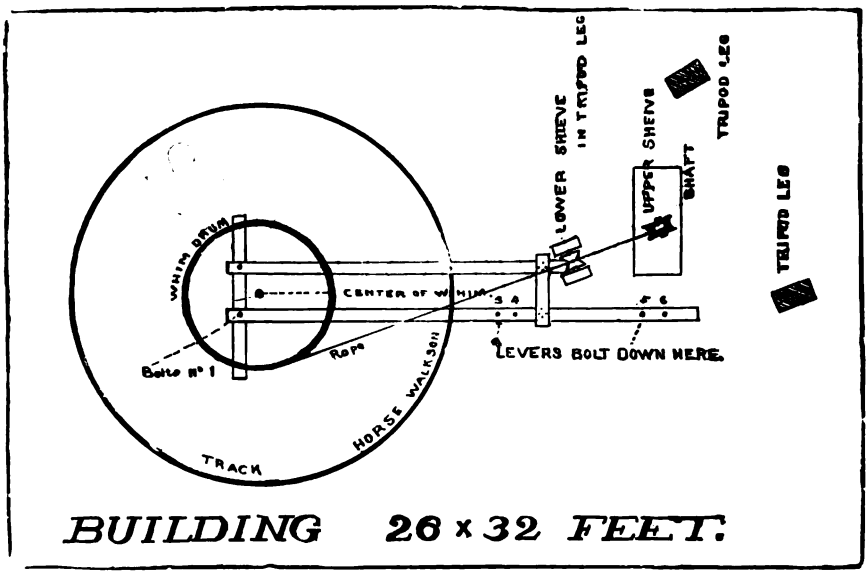
If in sinking in a tunnel six feet wide, you will measure eighteen feet along the tunnel from where you want the shaft, and grade out seven feet from each side, as shown in the ground plan, tapering down to nothing at each end and forming a circle twenty feet in diameter. Thus, without much excavating a Whim can be worked underground in a tunnel. If the shaft be next the mouth of the tunnel the horse can cross over it, to reach the Whim, by closing down the trap door and allowing the horse to walk over it.

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CUT No. 1—SIDE ELEVATION

Cut No. 1 shows a side view of how the tripod and whim are set. The ends of two sticks are set into the ground, while the ends of the other two are bolted to the sills, upon which the whim with the break clutch and lever is worked. It also illustrates the manner in which the ore bucket is handled when being hoisted from an incline shaft and dropped on a car. Two pieces of wood are bolted, one on each side of the bucket, to be used as guides. They correspond in width to the timbers or guides running down the shaft, thereby keeping the bucket, when being raised or lowered, from striking the sides.



Cut No. 2 shows the ground plan, with the size building, if one should be required. It also shows the position of the sheaves, tripod feet, brake lever and clutch lever The large circle represents the circle in which the horse travels when working the whim. The small one is the weighing drum, with the cable leading to the lower sheave on tripod.

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Information Required

In asking for quotations please answer as many of the following questions as will suit your proposition; and, if possible, refer to cut on page of engine that will best suit your purpose.

Type of engine.....

Number of drums or reels.....

Load { Car..... / Cage..... / Rope..... / Rock.....

Total.....

Average speed of load.....

Shaft: vertical or incline .....

Angle of slope from the horizontal.....

Present depth of shaft.....

Ultimate depth of shaft.....

Diameter and face of drums or reels.....

Size of rope.....

Feet of rope on each drum.....

Drum: loose or keyed.....

Are cages to run balanced or unbalanced?.....

Clutch: jaw or friction.....

Clutch: steam or hand.....

Brakes: post or band.....

Main brakes: steam, hand or foot.....

Crank disc brakes, steam, hand or foot.....

Reverse gear: steam or hand .....

Indicator: type.....

Cut-off, hand or automatic.....

Frame.....

Cylinders: diam. and stroke.....

Cylinders: jacketed or unjacketed.....

Steam or Air Pressure at Engine.....

Distance of engine to shaft.....

Centre to centre of overhead sheaves in shaft house.....

What type of Engine have you now in use?.....

At what date do you want machines Shipped? .....

Boilers.....

Number.....

Type.....

Size or capacity.....

Steam pressure.....

Diam. and height of chimney.....

Kind of fuel.....

Do you want Overhead Sheaves?.....

Do you want Feed Pump?.....

Do you want Heaters?.....

Do you want Compressor?.....

Will other machinery be used with boiler?

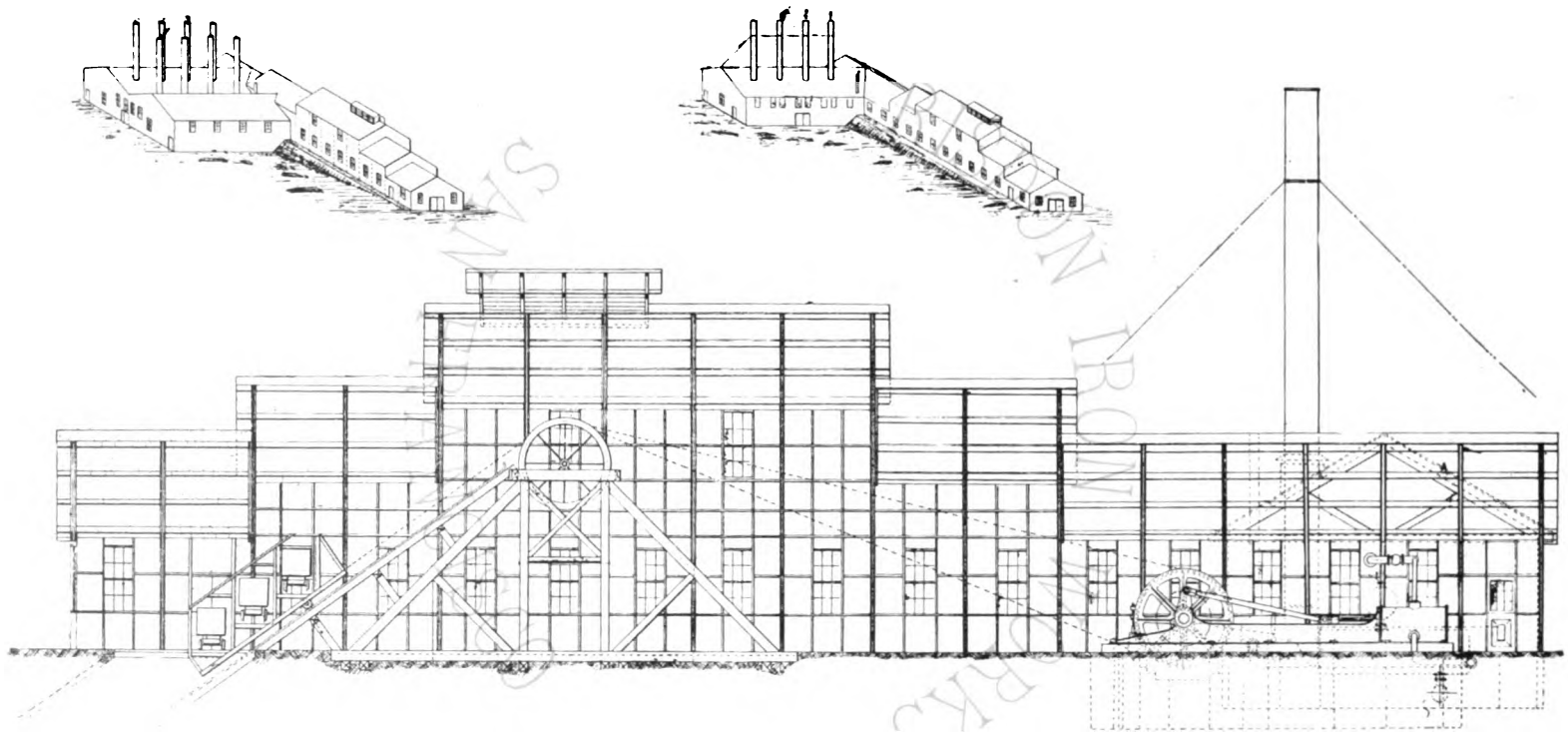
If so, describe same.....

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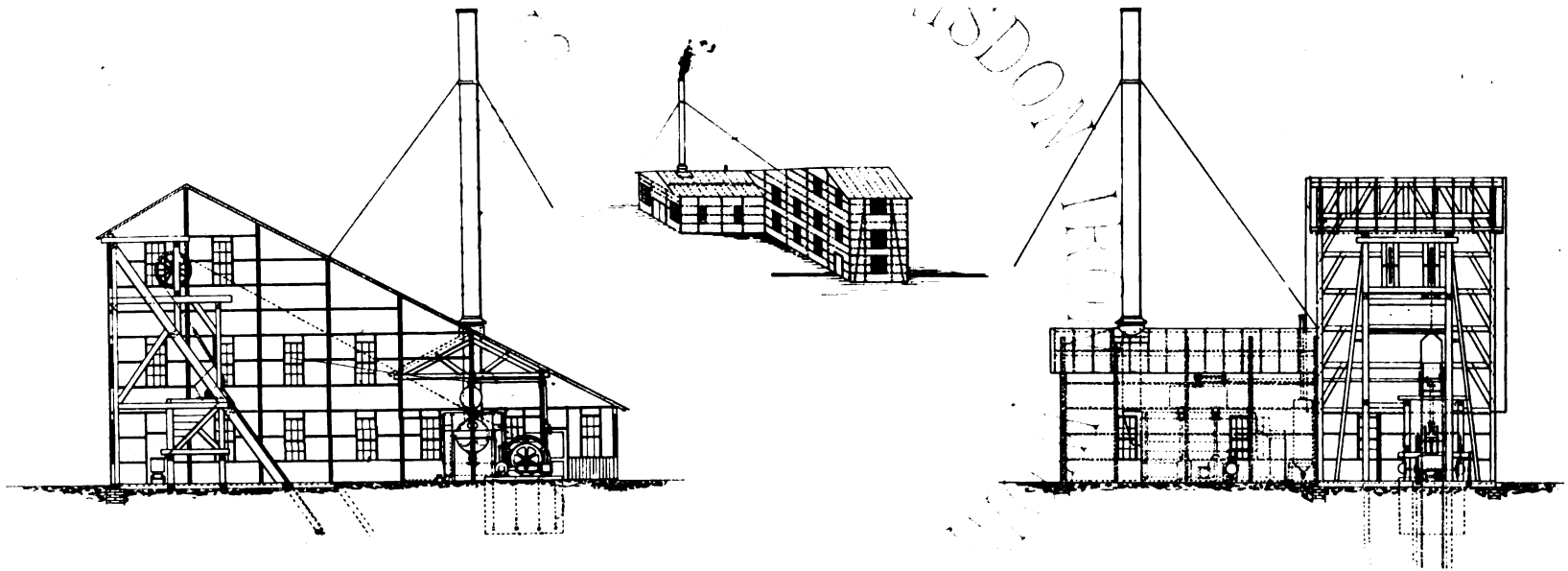
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GENERAL PLAN COMPLETE HOISTING WORKS

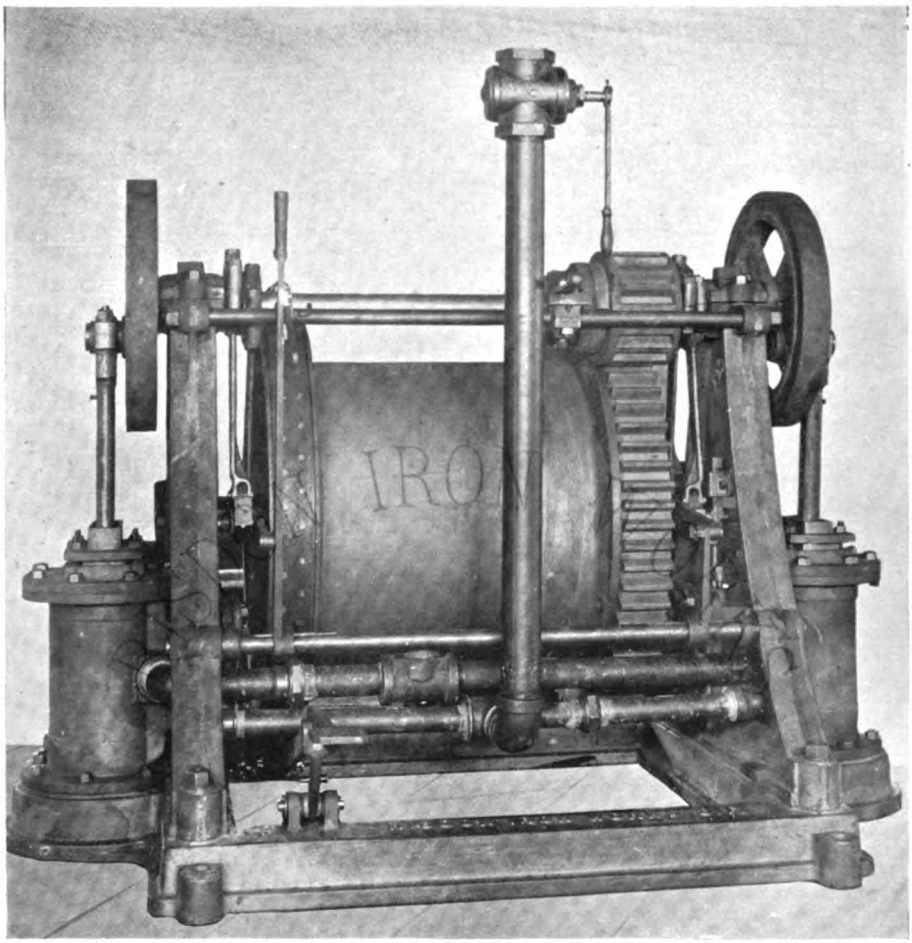
Load, 7½ tons Ore

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GENERAL PLAN HOISTING WORKS, SHOWING SELF-DUMPING APPARATUS

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Double Cylinder Reversible Hoisting Engine

WITH LINK MOTION AND CLUTCH AND BRAKE

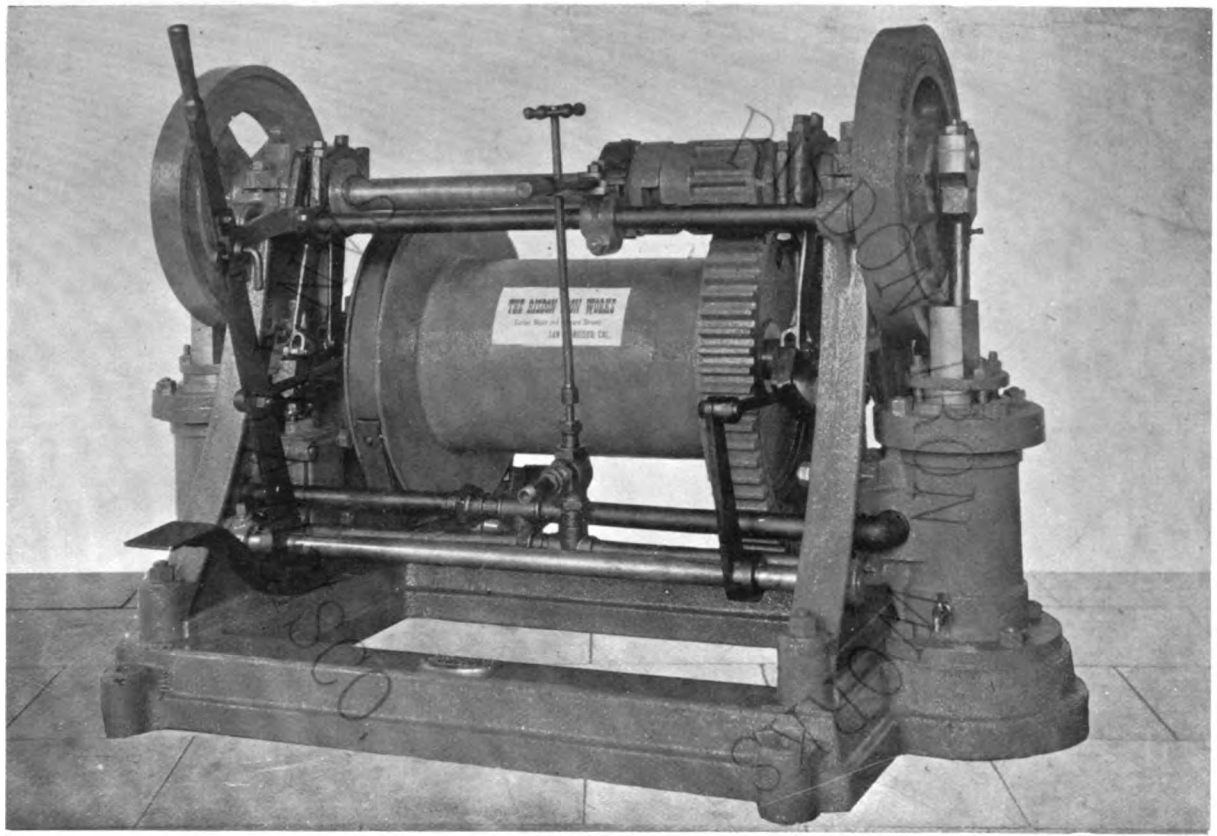
The cut herewith illustrates our Self-contained, Double Reversible Link-motion Hoist, which is particularly adapted to any class of hoisting where steam or compressed air is used.

The Drum is provided with strap brake. For small mines, shafts and inclines it is especially fitted, and should commend itself to all mine owners an account of the small amount of floor space occupied. Being very compact it is easily handled and set in position. The eight horse-power 5 x 5 inches is always kept on hand ready for prompt shipment.

TABLE OF DIMENSIONS.

Horse-power.	Diameter of Cylinders	Drum		Weight will lift 150 to 200 ft. per minute, pounds	Floor Space in Inches
		Diam.	Length		
8	5 x 5	12	20	1,300	58¾ x 33½
8	5 x 5	8	16	1,600	44 x 30
12	6 x 6	16	24	2,000	70 x 36
20	7 x 7	20	24	3,000	74 x 42
24	8 x 8	24	24	4,000	74 x 48
36	9 x 9	28	28	5,500	88 x 58

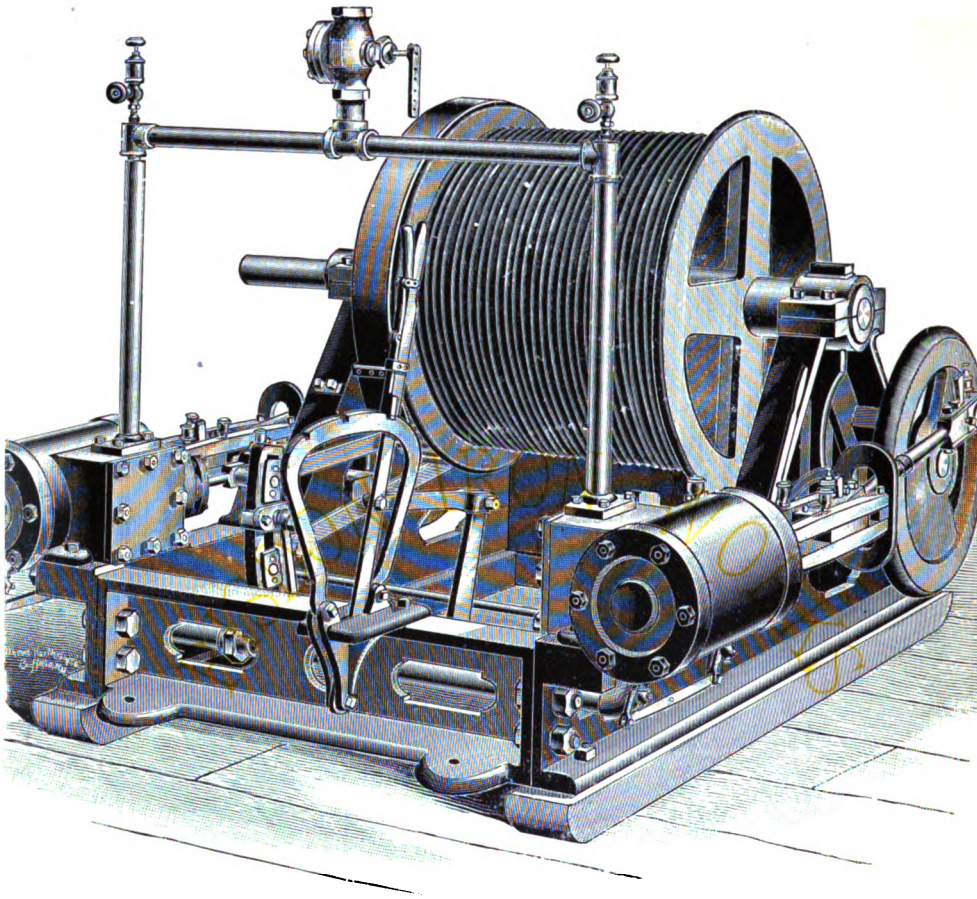
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The above cut illustrates our 9 x 9 Trunk Engine for Prospecting or Sinking Winzes

FOR PARTICULARS SEE OPPOSITE PAGE

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Double Cylinder, Reversible Link Motion Mine Hoisting Engine

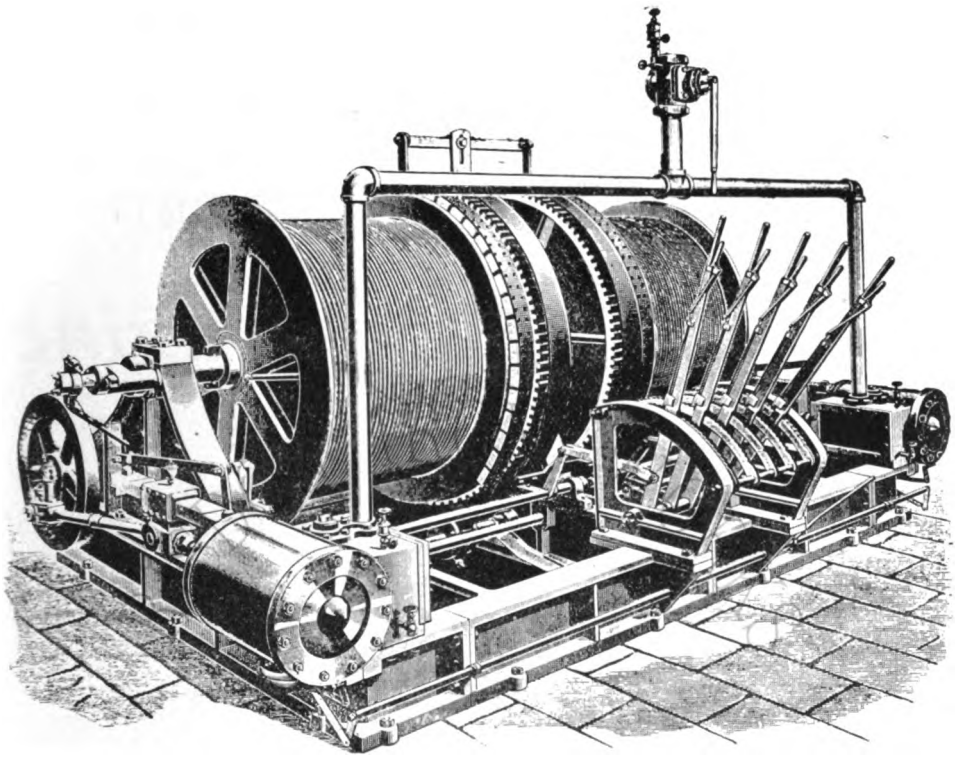
With or without Automatic Brake, as desired.

These engines having large drums, are particularly adapted for mines, inclines, and other rapid hoisting. The drums are either plain, lagged, or grooved as desired, and lagging or grooving is done for ¾, ⅞ or 1 inch wire rope, as ordered. The engines being reversible, two loads or hoists may be operated at the same time, one going down and the other coming up. They are very simple and strong in design and construction, rapid in motion, easily handled and occupy but comparatively little floor space, while the best results are produced in their efficient working. Each engine is fully equipped with fittings, and supplied with automatic brake, when so specified in order. These engines are made with either friction or reversible link motion, or both as desired.

SIZES, DIMENSIONS, CAPACITIES, WEIGHT, SPEED, PRICES, ETC.

Number	Horse Power	Dimensions of Cylinders		Dimensions of Drum			Dimensions of Bed Plate		Shipping Weight, pounds	Price of Engine complete	No. ft. Drum will hold, Single Coil			Speed per minute in feet	Weight Hoisted Single Rope, pounds
		Diameter Inches	Stroke Inches	Diameter Inches	Length Inches	Diameter Flanges	Width Inches	Length Inches			¾ inch Wire Rope	⅞ inch Wire Rope	1 inch Wire Rope		
29	20	7	10	30	26½	36	54	74	4500	$ 805	278	238	208	325	2000
30	25	7¾	10	30	26½	36	54	74	5500	900	278	238	208	325	3000
31	30	8½	10	30	26½	36	54	74	6500	1,050	278	238	208	325	4000
32	40	9	12	48	48	54	76	92	12000	1,510	804	687	603	517	4500

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DOUBLE CYLINDER, DOUBLE DRUM MINE HOISTING ENGINE

The above cut represents our Double Cylinder, Double Drum Mine Hoisting Engine, which we furnish either with friction as shown in cut, or with reversible link motion instead, at same price.

This engine is specially designed for double compartment shafts and double track inclines, where it is desired to handle two loads at once independent of each other, or to lower one load and raise the other.

The machine is very strong and compact and is easily transported and erected.

TABLE OF PRICES, SIZES, WEIGHTS, ETC.

Horse Power.	Size of Cylinders.		Sizes of Hoisting Drums. Each Drum.		Average Hoisting Capacity, pounds.	Average Hoisting Speed, per Minute.	Estimated Shipping Weight, pounds.	Price Complete.
	Diameter Inches.	Stroke Inches.	Diameter Inches.	Length Inches.				
20	7	10	30	30	3000	300	8000	$1,500
30	9	12	48	30	4000	350	10000	2,000
50	12	15	60	42	6000	400	25000	3,000
75	14	18	72	48	7000	450	35000	4,000

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Double Cylinder
Double and Single Drum
Geared Hoisting Engine

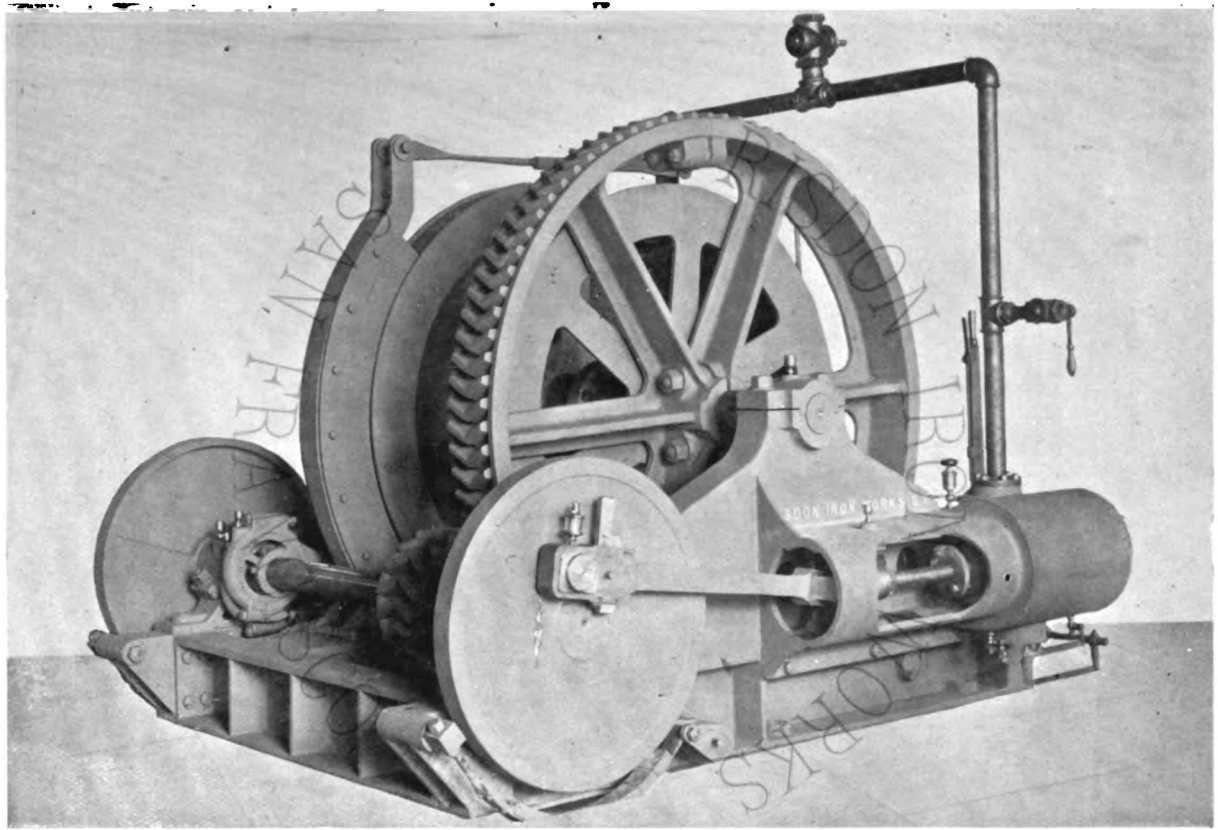
Back Geared and Self-Contained

Reversible Link Motion or Friction Drums

Built for Flat (see cut page 19) or Round Rope (see cut page 20)
Cut Single Drum, page 20.
Cut Double Drum, page 23.

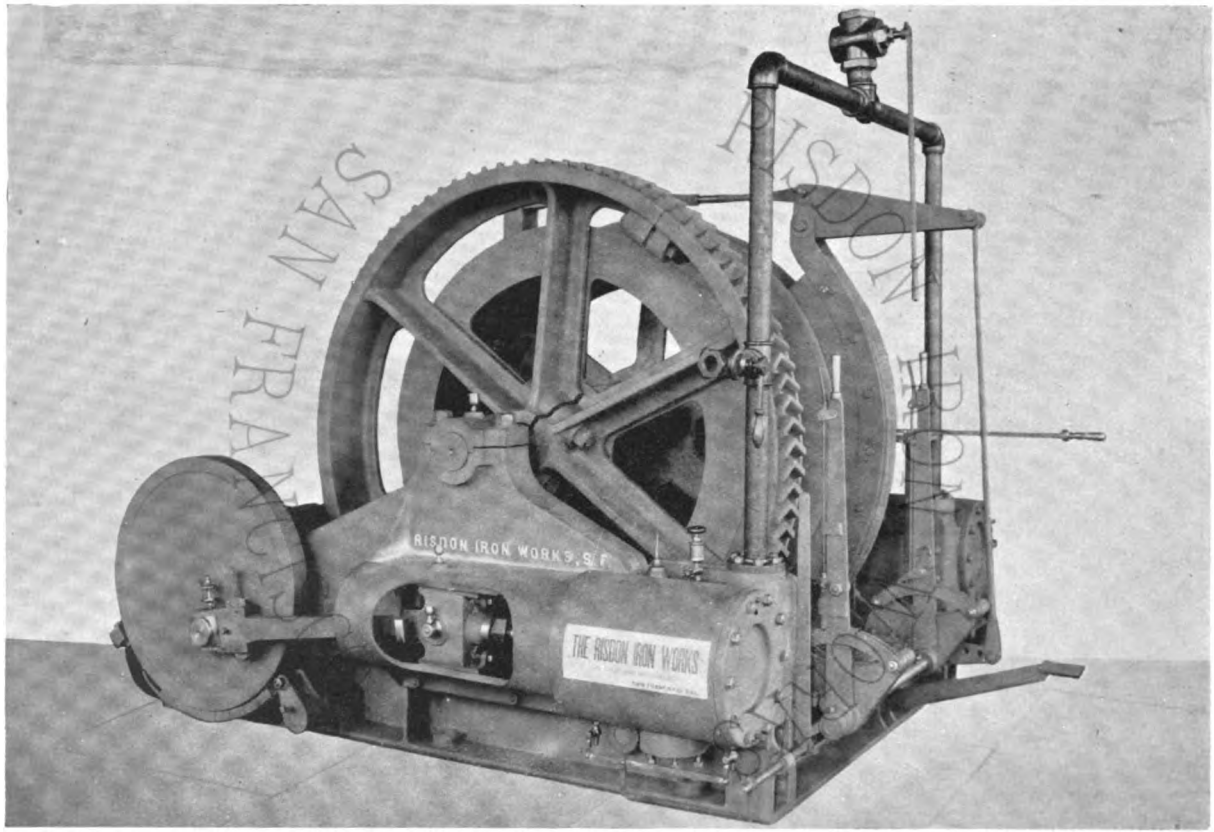
The illustrations on pages 19 to 23 show several styles of our self-contained hoisting engines. It will be noticed that they are equipped with substantial post brakes as well as brakes on discs. The clutches are on main drum, and are a great improvement over other engines which have clutch on pinion shaft. This style of engine can be used underground and bolted down to station timbers without cutting out any ground below timber, and this is a great advantage over other styles. We have equipped a large number of mines with the style shown in cut on page 19 for underground work.

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Double Cylinder Single Drum Self-Contained Hoist

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Double Cylinder, Single Reel, Self-Contained Hoist.

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LIST OF SIZES

(**Single and Double Drum Self-Contained**).

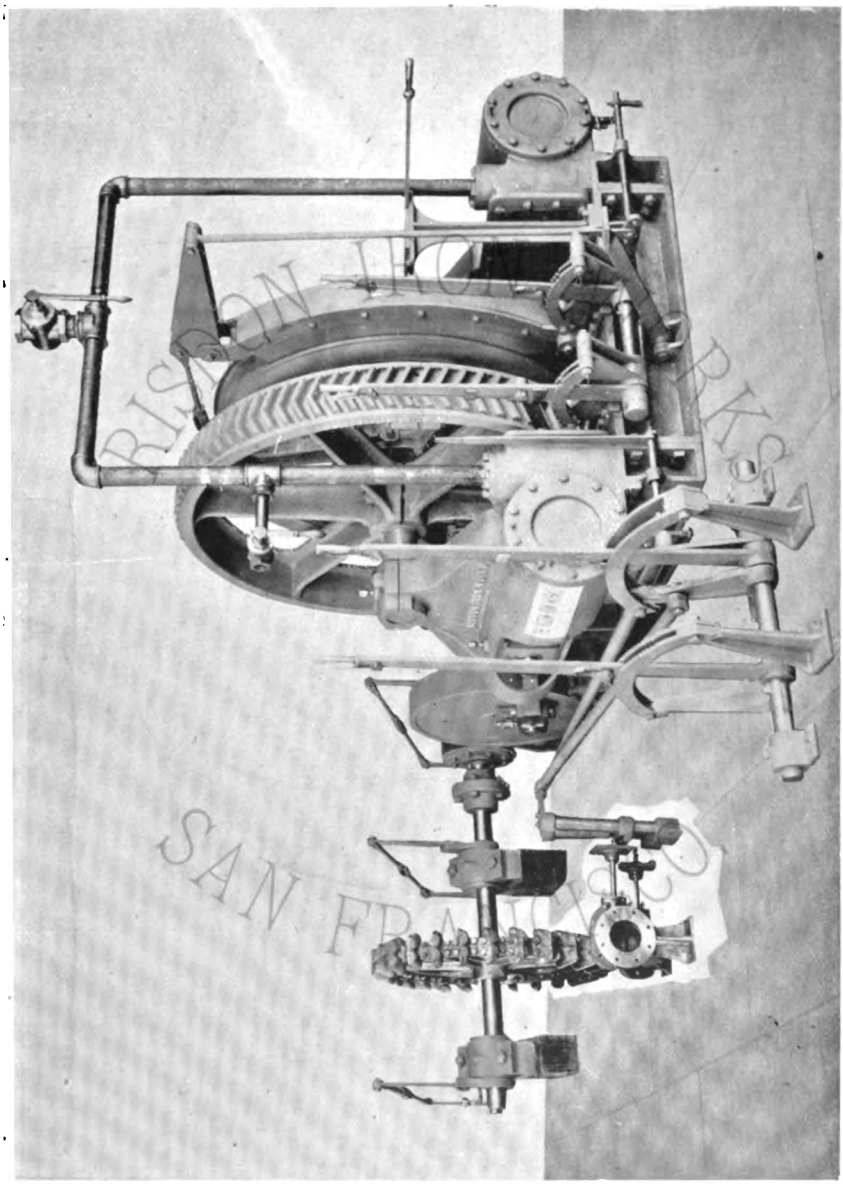
Diameter Cylinder	Stroke	Diameter Drum	Width Drum	Diameter Gear	Diameter Pinion	Capacity
10	12	48	24	60	12	5500
12	14	54	24	78	16	8000
14	18	60	24	102	21	12500
16	24	66	36	100	20	20000
18	24	72	36	124	24	25000

SAME WITH LONG STROKE

14	28	72	24	90	30	8000
16	28	84	24	100	20	11100
18	30	96	24	144	36	17000

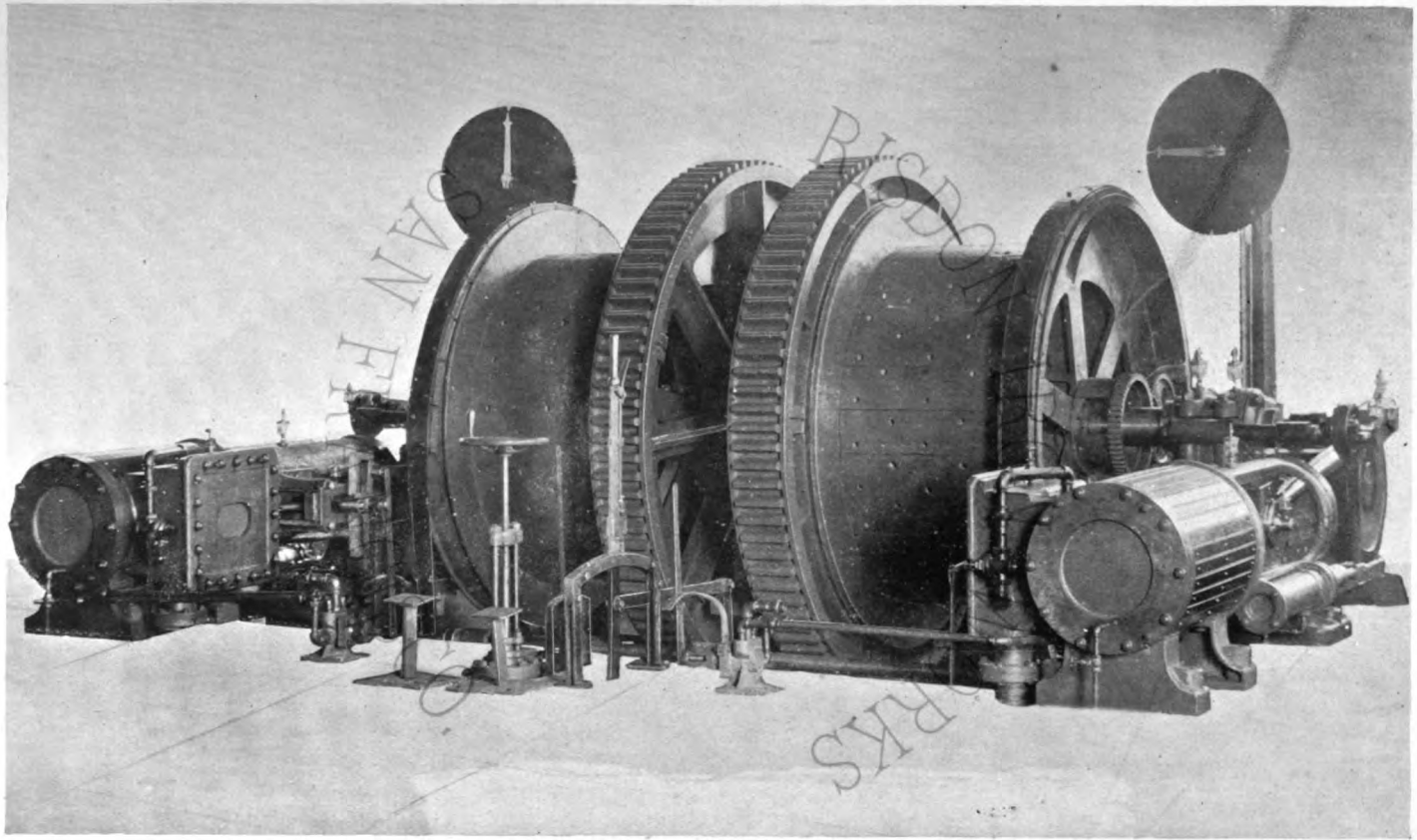
Speed usually is 400 to 600 feet per minute, but can be run from 600 to 1000. All gears changed to suit requirements of speed and load.

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DOUBLE CYLINDER, SELF-CONTAINED STEAM AND WATER POWER HOIST

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DOUBLE CYLINDER, DOUBLE DRUM, SELF-CONTAINED HOIST

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Double Cylinder, Double or Single Drum, Geared Hoisting Engine

On the opposite page and on pages 28 and 29 we illustrate our Double Drum Engine. This engine is built with balanced slide valves, post brakes on drums, band brake on pinion shaft, toe clutches, and link reversing gear. The main gear and pinion are made with Helical teeth, and the latter bushed with phosphor bronze.

LIST OF SIZES.

Diameter Cylinder	Stroke	Horse Power	Drum		Capacity lbs
			Diameter	Length	
10	12	50	36	18	4500
12	16	100	48	20	5000
14	18	150	60	24	7000
16	18	200	72	24	10000
18	20	300	78	48	20000

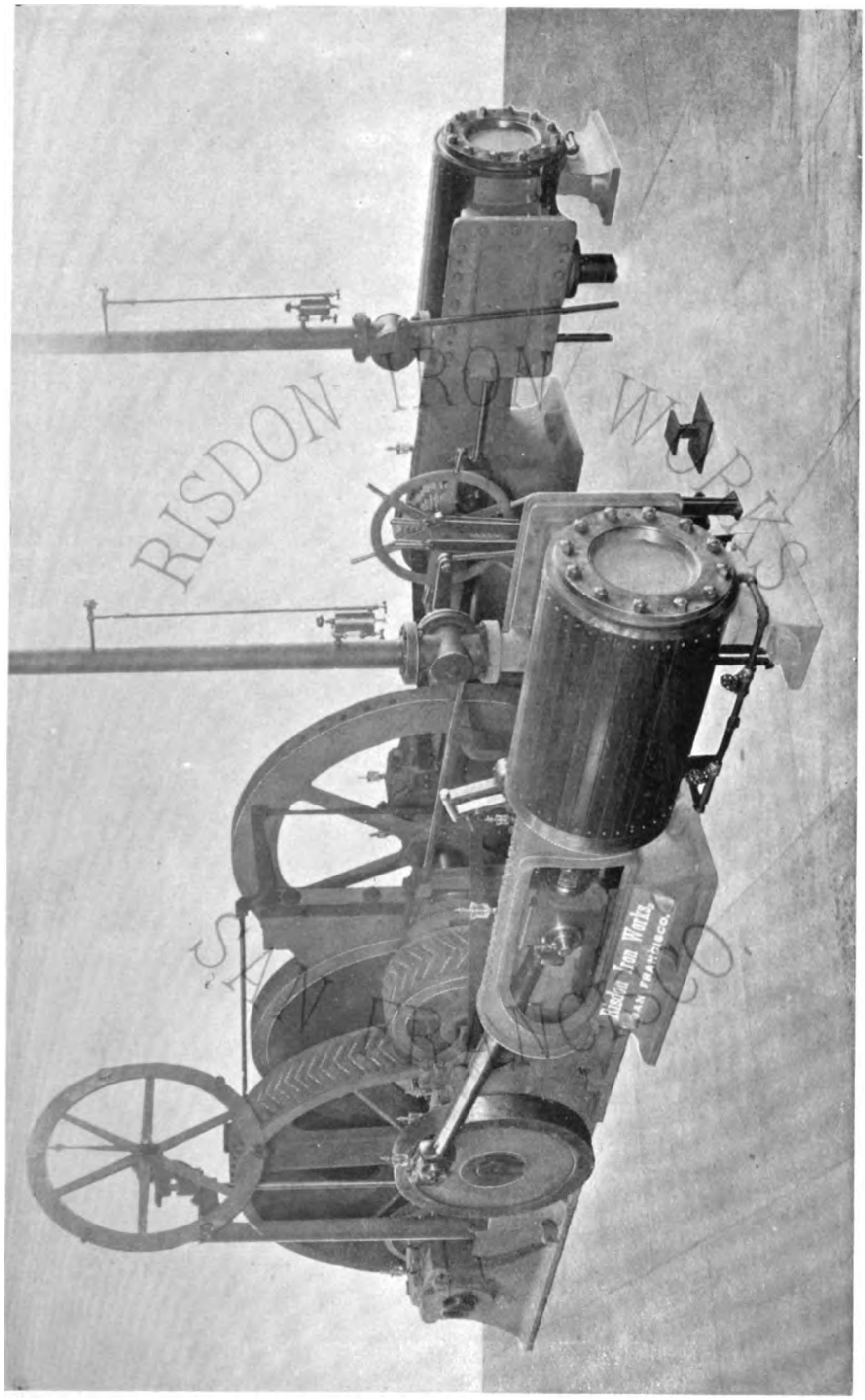
The speed will depend on gearing, but will run from 300 feet to 600 feet per minute.

SPECIAL HEAVY ENGINES SAME STYLE AS ABOVE.

12	20	100	60	24	7000
14	28	200	60	24	8000
16	28	250	72	24	11000
18	30	300	78	24	17000

Double Drums pages 26 and 27. Single Drum pages 25 and 28. Also built for Flat Rope.

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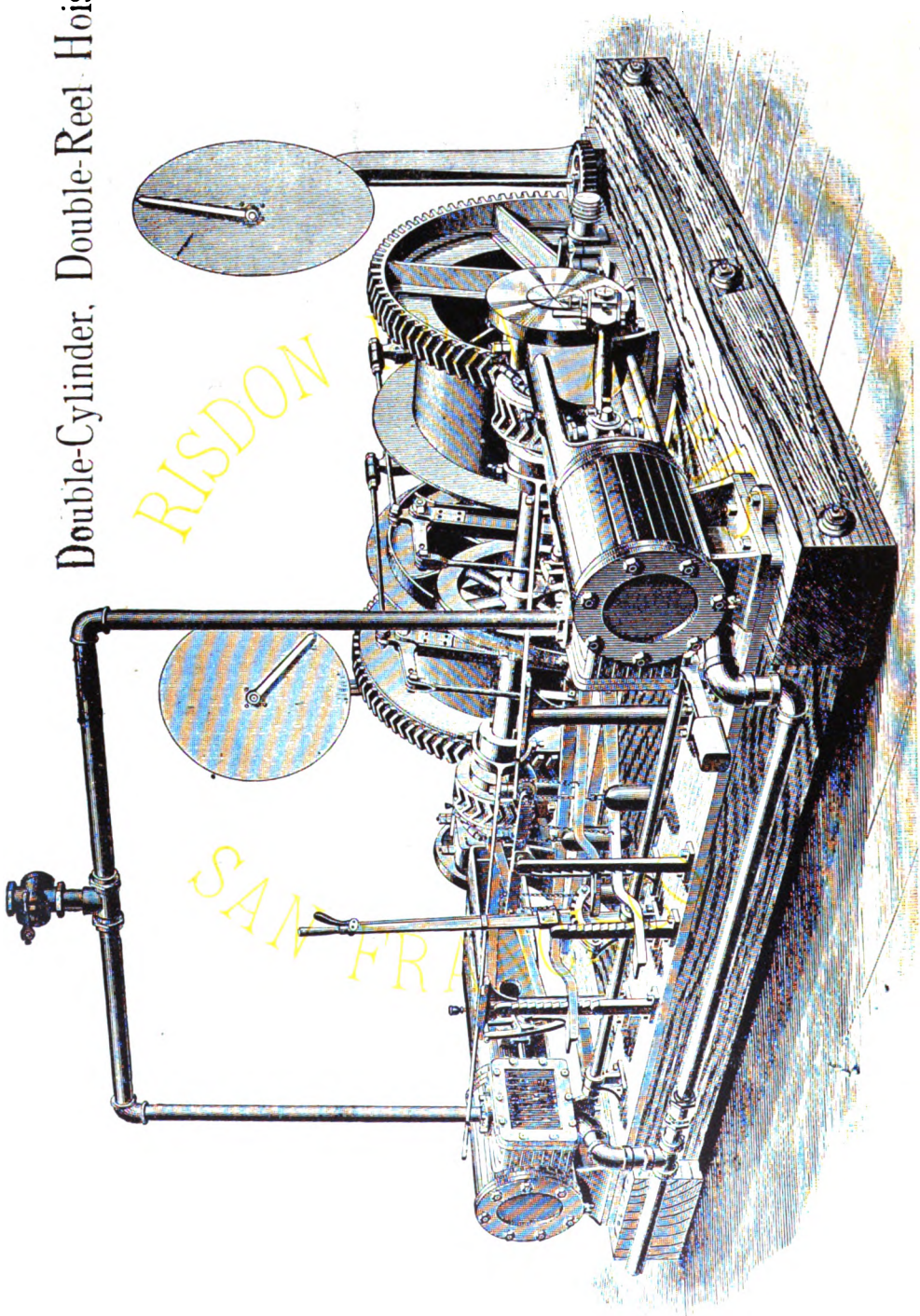


DOUBLE CYLINDER SINGLE DRUM HOIST (*Virtue Pattern*)

RISDON IRON WORKS
SAN FRANCISCO

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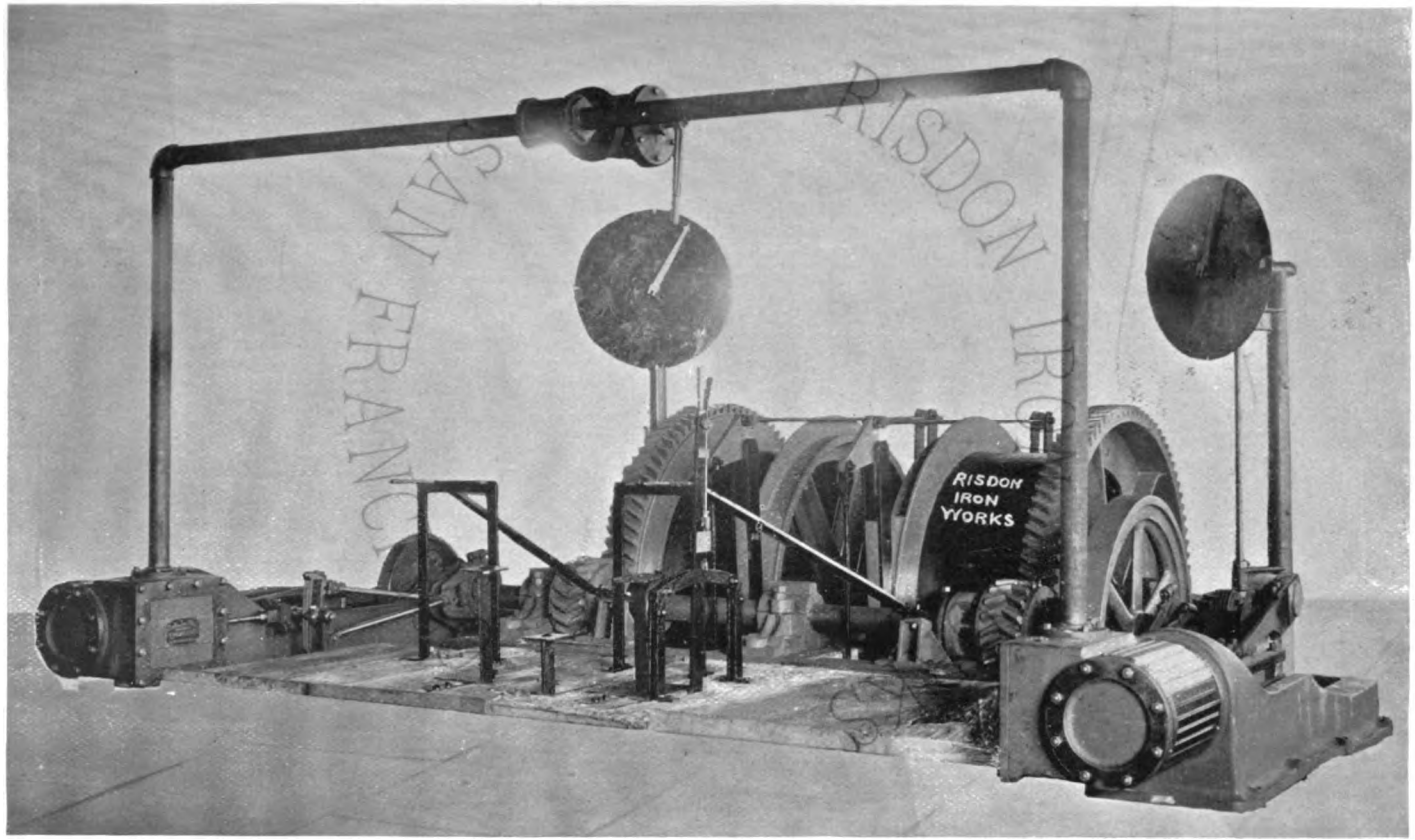
Double-Cylinder, Double-Reel Hoist.



RISDON
SAN FRA

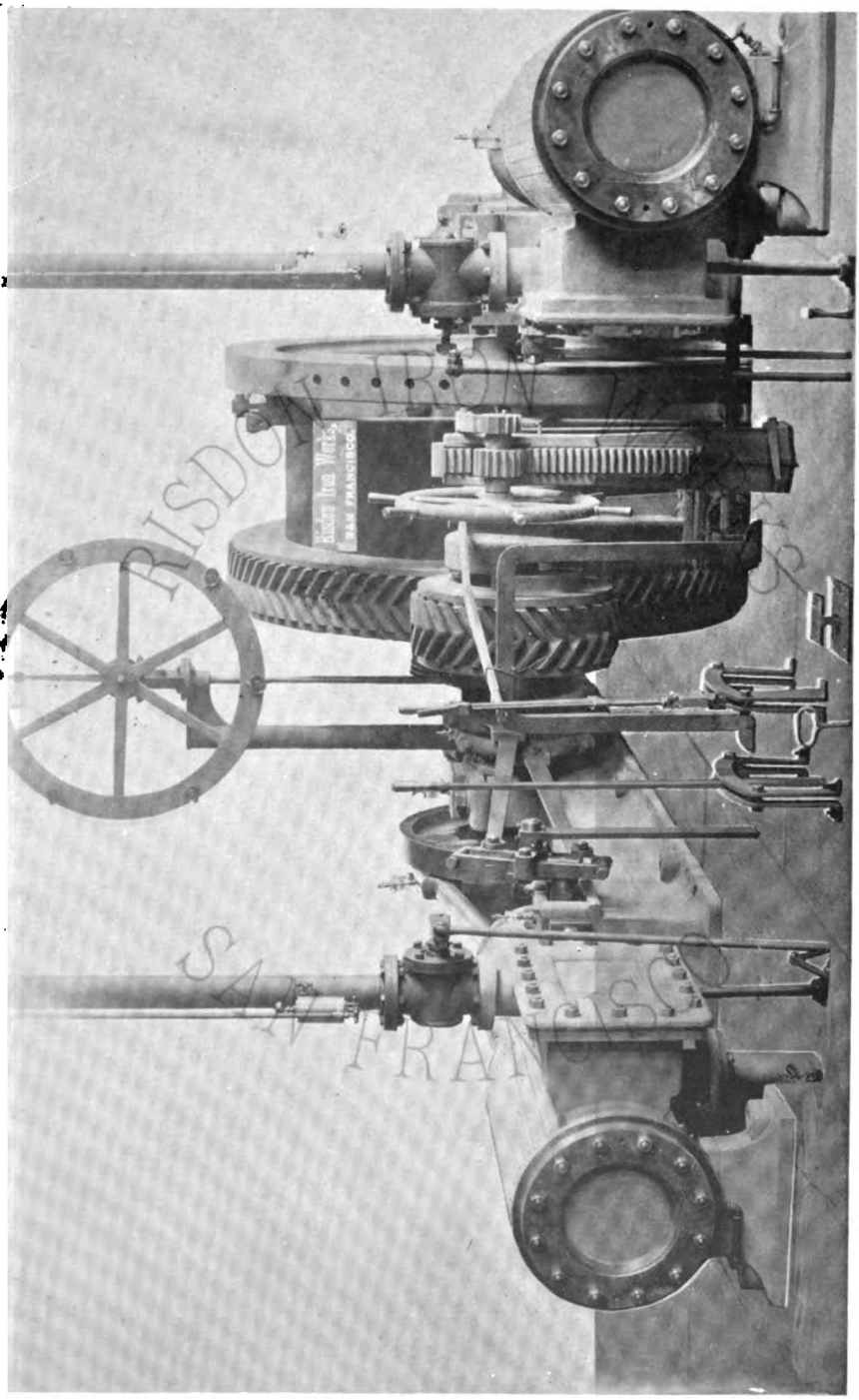
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DOUBLE CYLINDER, DOUBLE DRUM HOIST (Alma Pattern)

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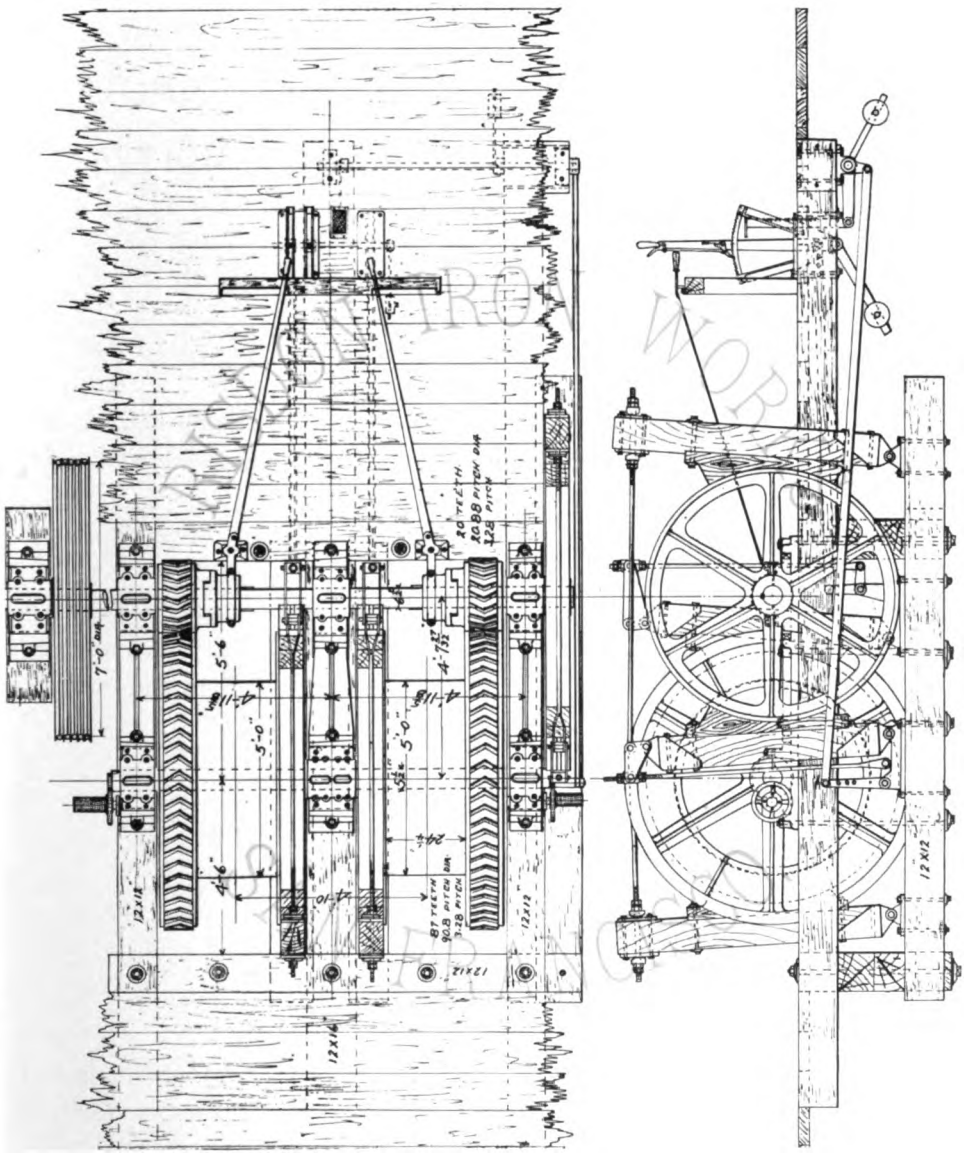


Double Cylinder, Single Drum Hoist (Virtue Pattern)

RISDON IRON WORKS SAN FRANCISCO

THE JOHN [illegible]AR

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Double Drum, Spur Geared, Water Power Hoist

(Gwin Pattern)

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SINGLE AND DOUBLE DRUM WATER POWER HOISTS WITH RISDON PATENT WATER WHEELS GEARED.

We illustrate on pages 29 and 31 two of our geared pattern hoists. The hoist is of the very latest design and embodies all the known appliances for safety and rapid work.

The clutches are on pinion shaft, but we build them on main drum shaft when required.

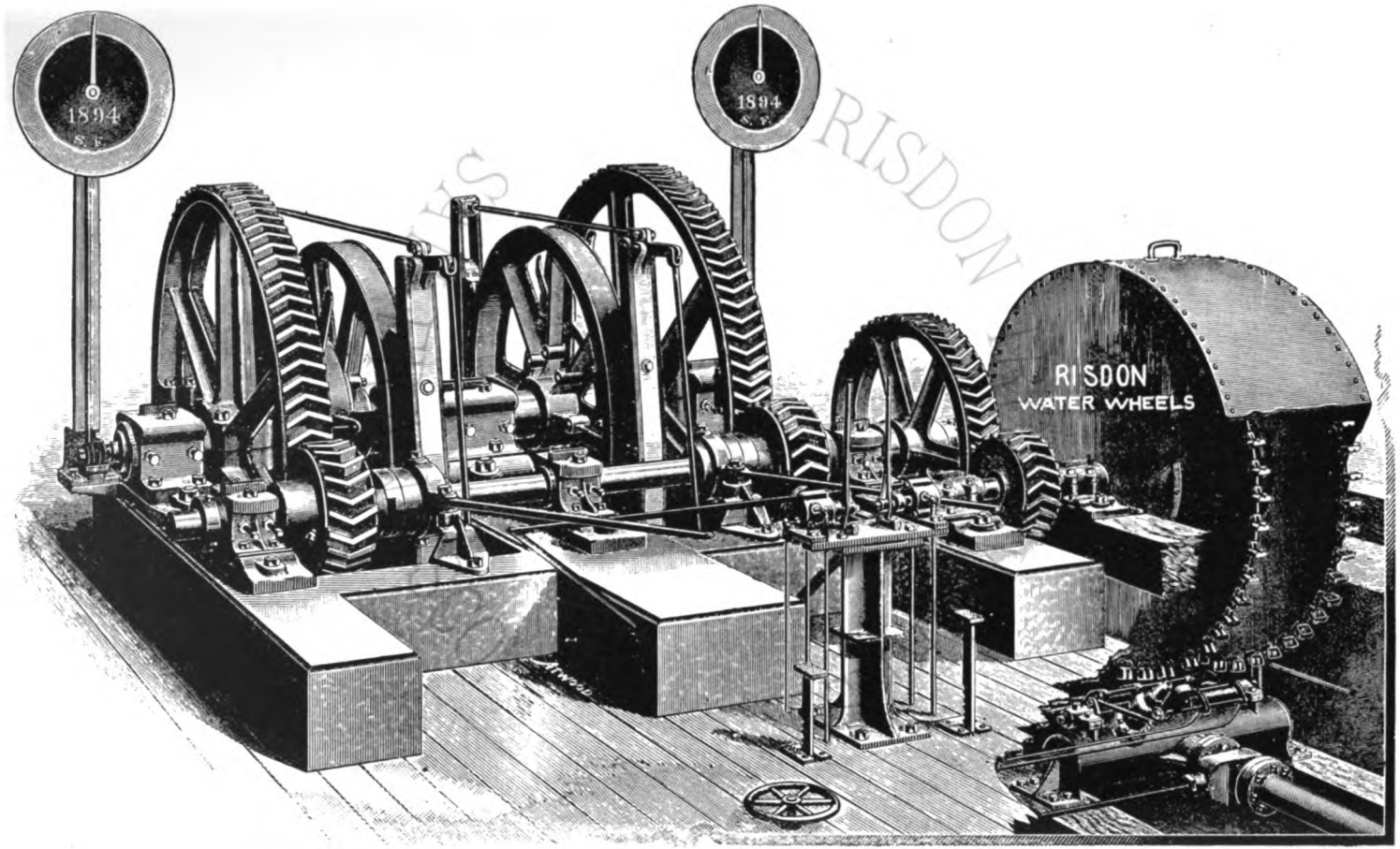
The indicators are operated by worm wheels. We show the double-geared type to reduce speed of fast running wheels, also the rope driver type on page 29, which is very popular. The nozzles are handled by levers or hydraulic pressure. The following are the standard sizes:

Diameter Drum	Diameter Reels	Diameter Gear	Diameter Pinion	Size Water Wheel
3 feet	2 feet	60	12	3 feet
4 "	3 "	78	16	4 "
5 "	4 "	90	20	5 "
7 "	5 "	100	20	8 "

For flat ropes we build special hoists to run counterbalanced when required.

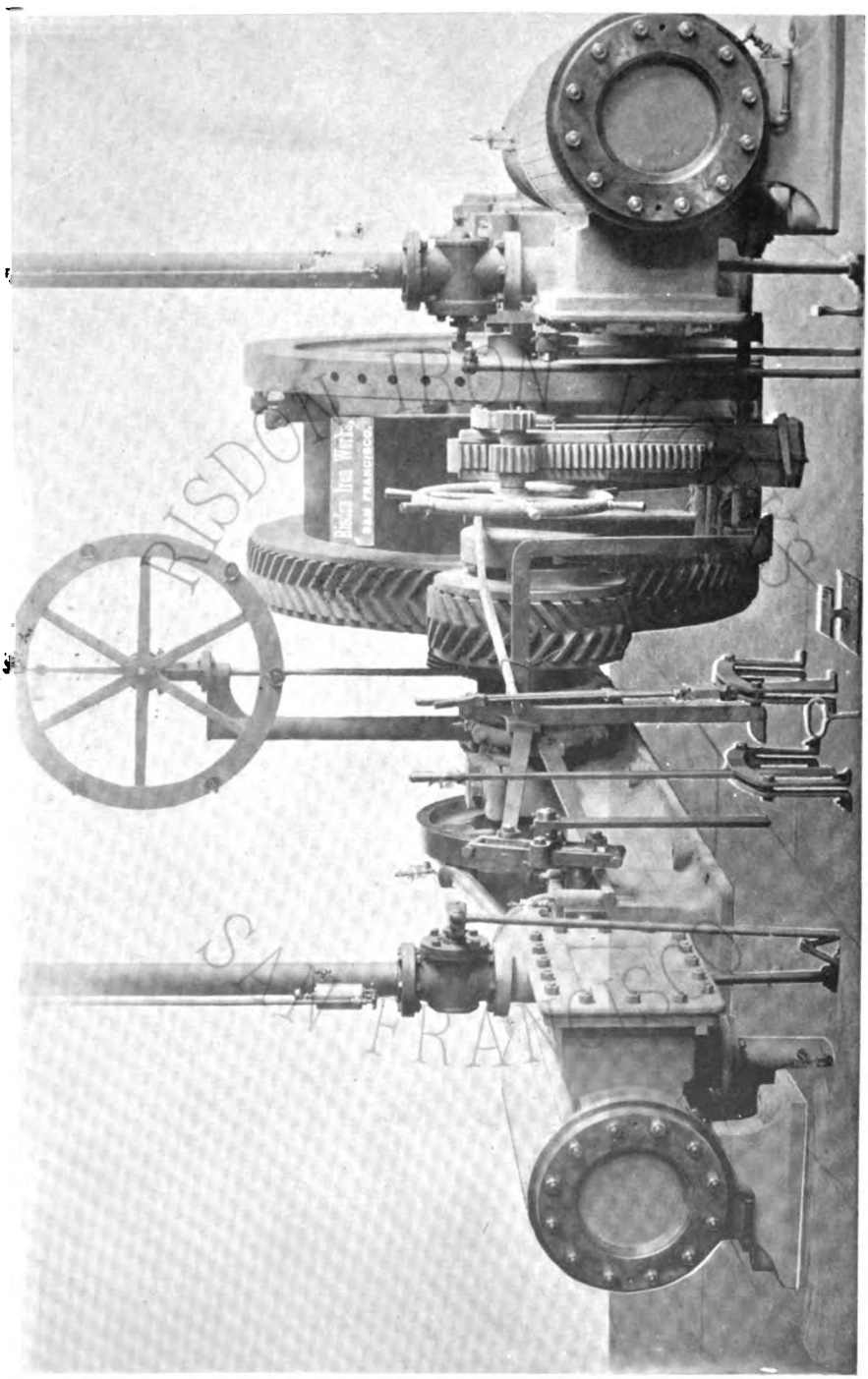
We also build water power outfits with water wheels connected direct on drums or reel shafts.

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DOUBLE REEL, SPUR GEARED WATER POWER HOIST (Ilex Pattern)

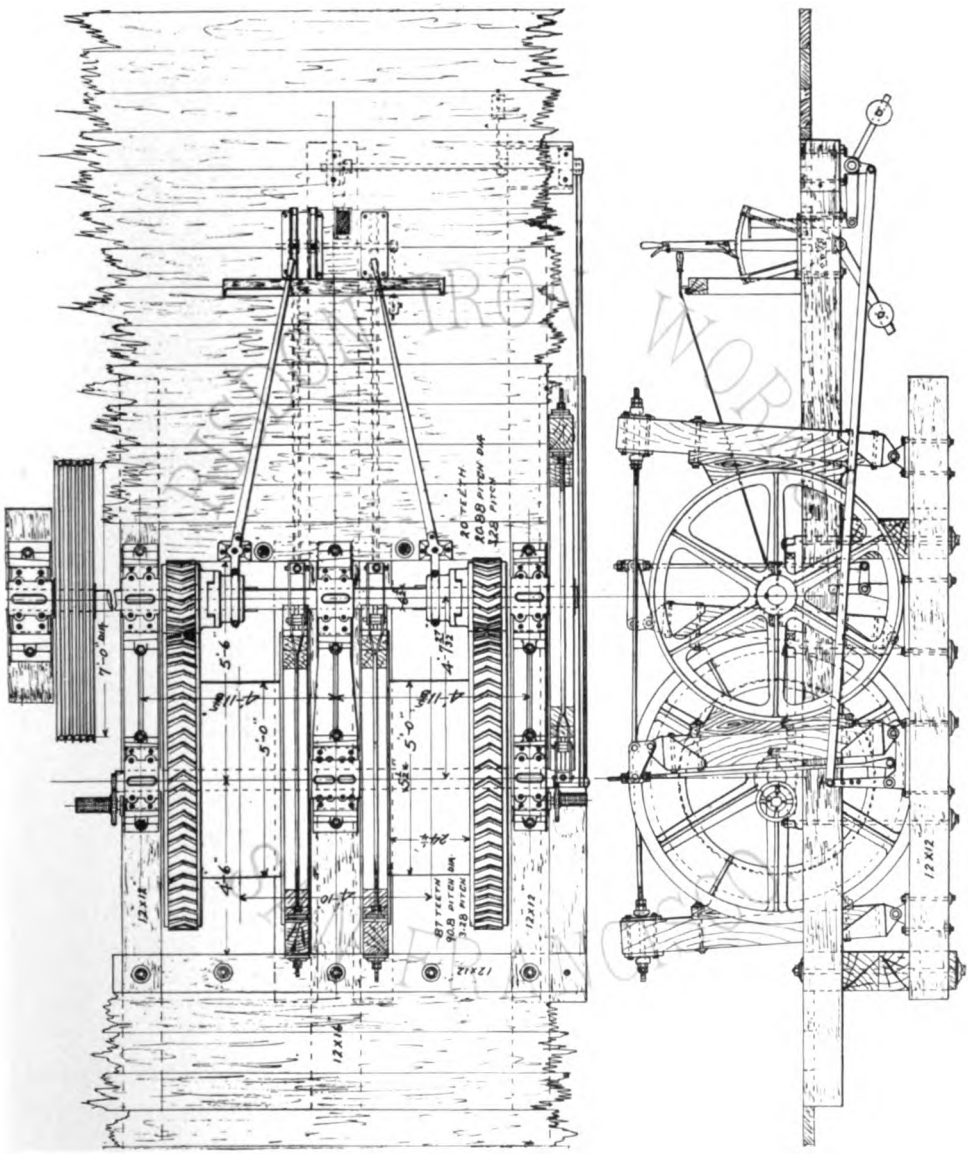
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Double Cylinder, Single Drum Hoist (Virtue Pattern)

RISDON IRON WORKS SAN FRANCISCO

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Double Drum, Spur Geared, Water Power Hoist

(Gwin Pattern)

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SINGLE AND DOUBLE DRUM WATER POWER HOISTS WITH RISDON PATENT WATER WHEELS GEARED.

We illustrate on pages 29 and 31 two of our geared pattern hoists. The hoist is of the very latest design and embodies all the known appliances for safety and rapid work.

The clutches are on pinion shaft, but we build them on main drum shaft when required.

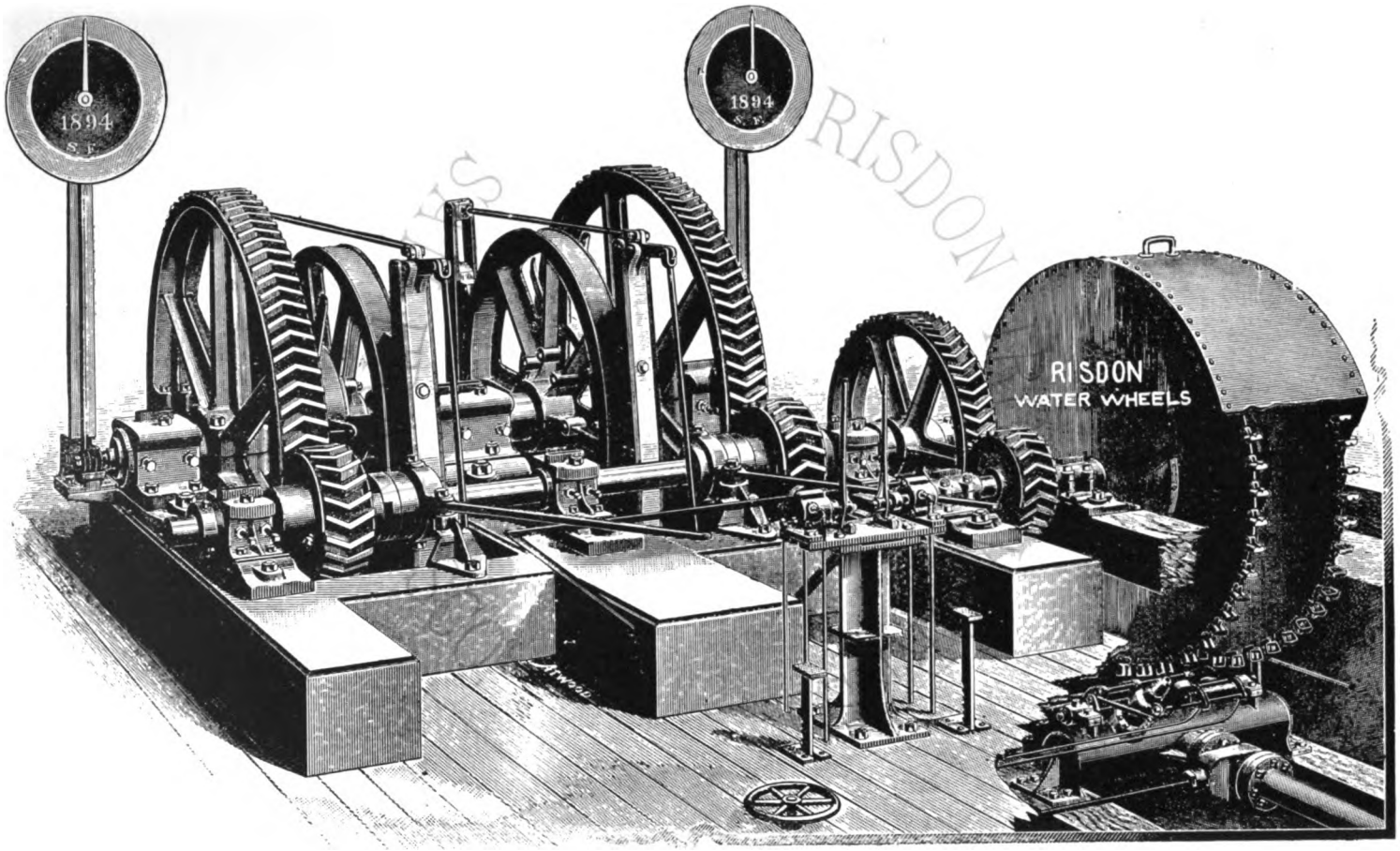
The indicators are operated by worm wheels. We show the double-geared type to reduce speed of fast running wheels, also the rope driver type on page 29, which is very popular. The nozzles are handled by levers or hydraulic pressure. The following are the standard sizes:

Diameter Drum	Diameter Reels	Diameter Gear	Diameter Pinion	Size Water Wheel
3 feet	2 feet	60	12	3 feet
4 "	3 "	78	16	4 "
5 "	4 "	90	20	5 "
7 "	5 "	100	20	8 "

For flat ropes we build special hoists to run counterbalanced when required.

We also build water power outfits with water wheels connected direct on drums or reel shafts.

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DOUBLE REEL, SPUR GEARED WATER POWER HOIST (Ilex Pattern)

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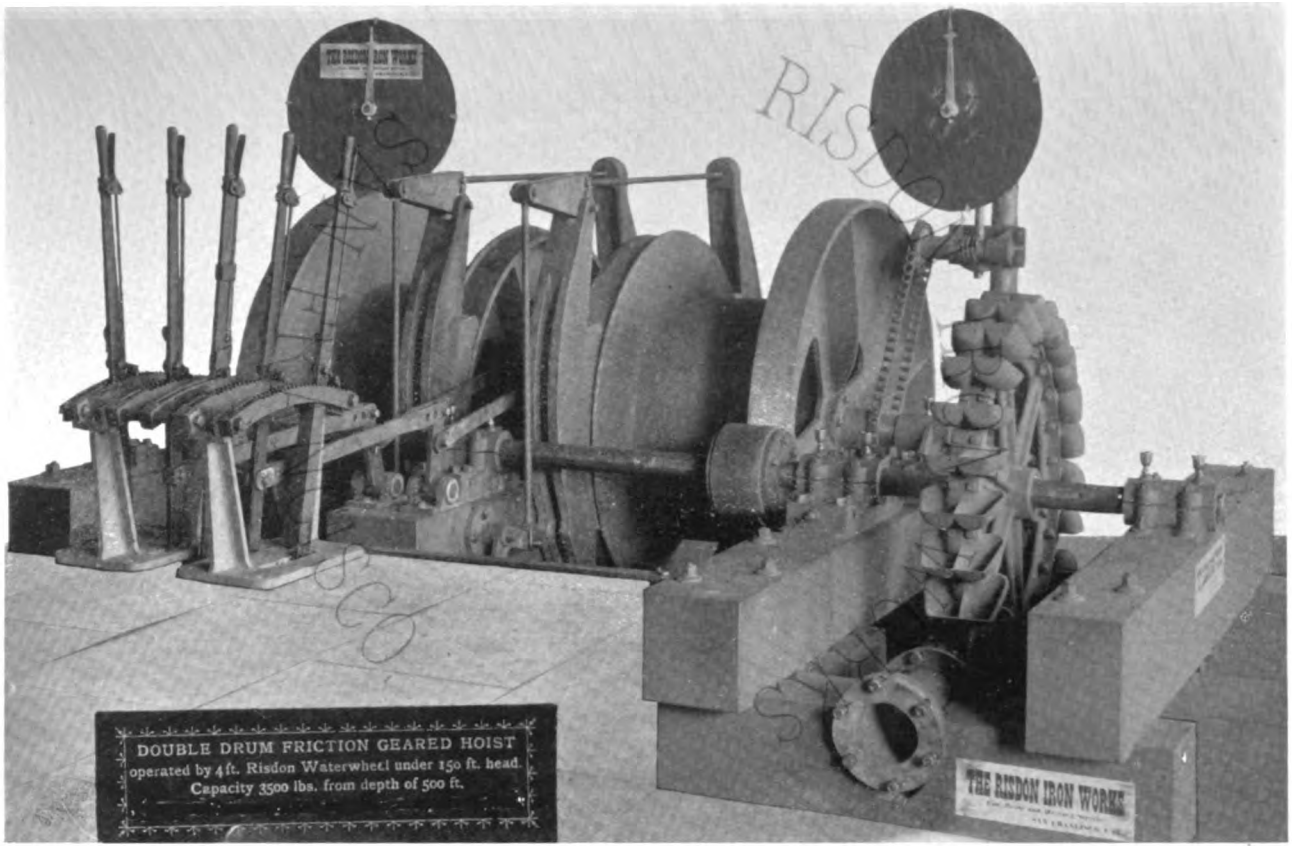
Single and Double Drum Water Power Hoist with Risdon Patent Water Wheels

We illustrate herewith one of our Water Power Hoists, which style is largely in use throughout the mining camps of this country, and is a reliable, steady running machine, which we strongly recommend to anyone having water power and using hoisting apparatus. The nozzle is controlled by a set of levers running within easy reach of the operator. It is generally intended in most hoisting works to lower the cage with the brake, but in some cases we have placed an additional wheel reversed on shaft, for lowering by power, or for using cages to balance each other. We build any size that may be required, but below is a list of a few of our standard sizes, with approximate weights and prices:

Diameter of Drum. Feet	Diameter of Friction Wheel. Feet.	Diameter of Water Wheels	WEIGHT Lbs.
3	3	36 inch	6000
4	5	48 "	10,000
5	6	60 "	12,000
7	8	72 "	24,000

We can build the above sizes either with single or double drums for round rope, or single or double reels for flat rope, and make each drum independent by means of a positive clutch or by using paper frictions, as shown.

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DOUBLE DRUM, FRICTION GEARED WATER POWER HOIST, (**Venus Pattern**)

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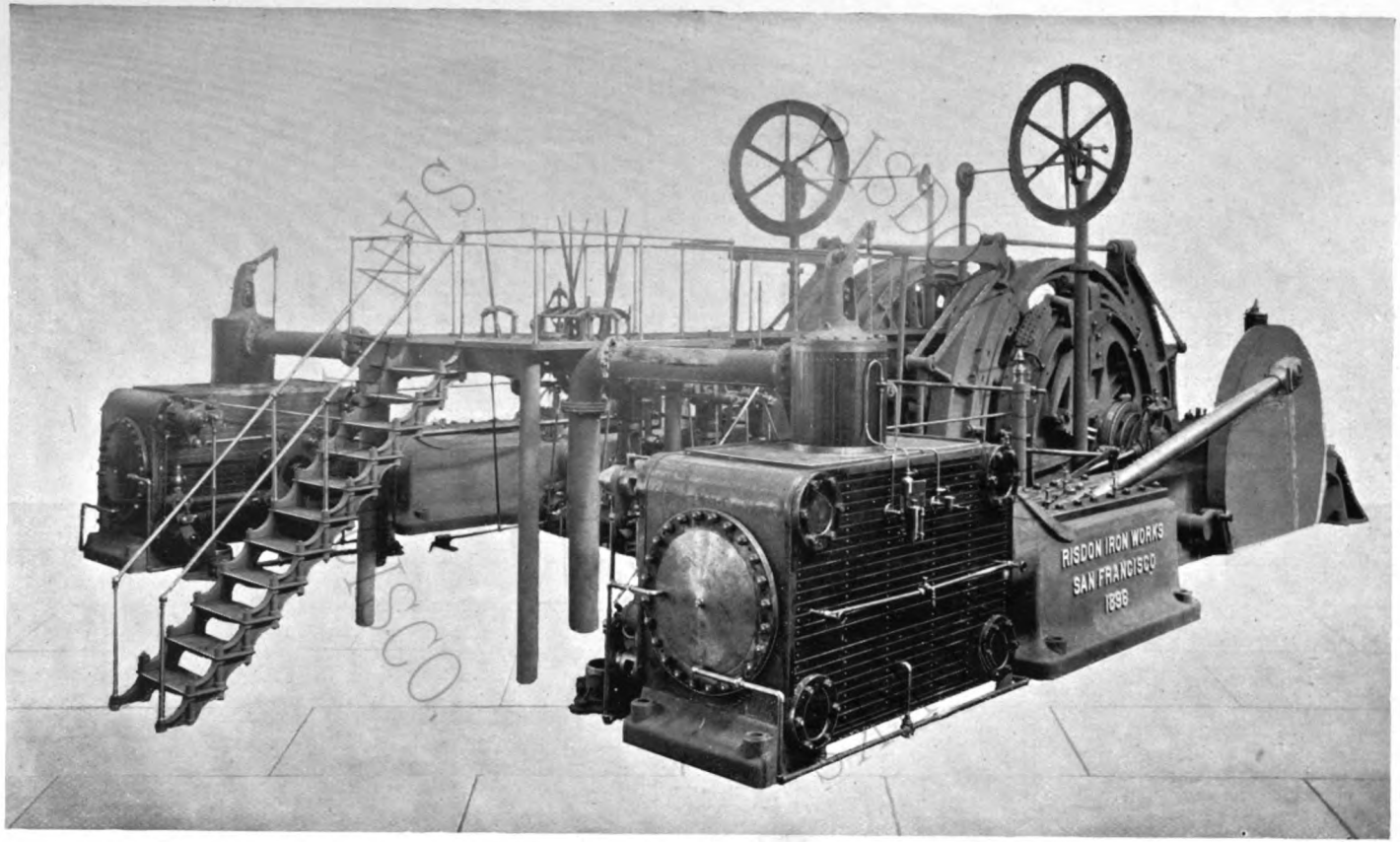
Our Large Direct Acting Corliss Hoisting Engines

The illustrations on pages 35 to 39 show one of our large first motion engines. The cylinders are 30x72, with reels 20 feet outside diameter. This hoist will handle a load of 40000 lbs., at an average speed of 3500 feet per minute, and the reels will hold 4000 feet of 8x1½ plow steel rope. All parts necessary for the operation of the engine are controlled by independent engines—that is, clutches, brakes, reverse, etc.

The brakes are made of cast iron or wrought iron—of the post pattern, on reels, and band pattern on discs. We make clutches of our Helical Tooth or Band Friction styles. Our large shafts are made of fluid compressed steel with hollow center. The brake wheels are made so as to allow for contraction and expansion caused by heating when rapid work is performed. We use the center bearing on all our large hoists, and also use automatic governors to regulate speed and cut off steam proportionate to work performed.

All parts are built very heavily to withstand the enormous strain produced by such rapid work. On page 36 is a list of the sizes that we usually build.

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DOUBLE REEL DIRECT ACTING HOIST, "FIRST MOTION" (Anaconda Pattern)

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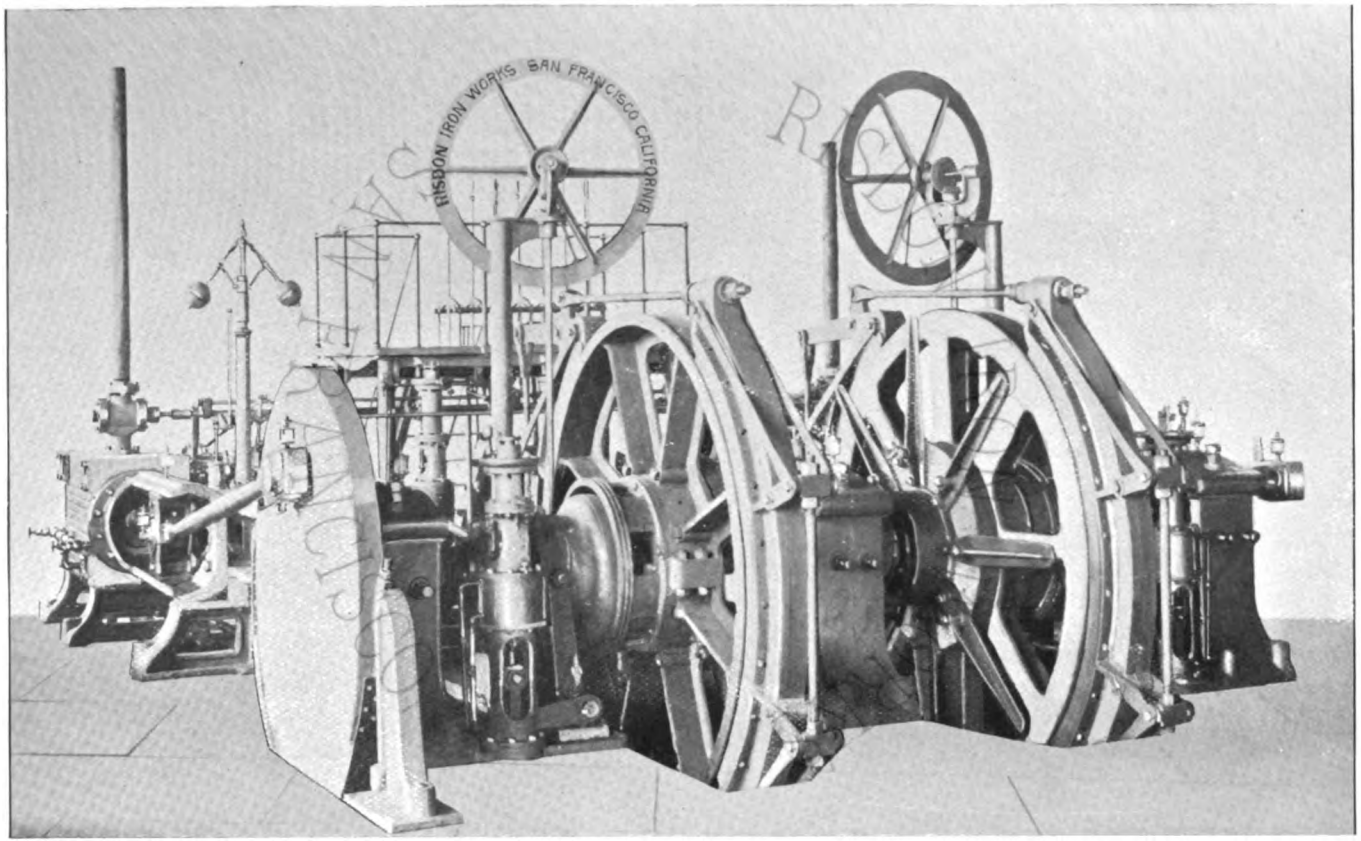
LIST OF SIZES

Direct Acting Hoisting Engines

Diam. Cylinder	Stroke Piston	Dia. Reel Center	Outer Diam. Reel Arms.	Size of Rope	Wt. Rope per Ft.	Amount Rope Reel will hold	Rev. Engine per Minute	Working Load from max. depth including rope	Average Speed Rope per Minute	Max. Speed Rope Eng. at Speed given
In.	In.	In.	Ft.	In.	Lbs.	Ft.		Lbs.	Ft.	Ft.
12	36	36	9	3x⅜	2.	1500	90	5400	1700	2500
14	36	36	10	3½x⅜	2.44	1800	90	7300	1700	2500
16	42	42	11	4x⅜	2.52	2200	80	9600	1700	2700
18	48	48	12	4x½	3.3	2200	75	14000	1700	2800
20	48	48	13	4½ x½	4.	2500	75	15000	2000	3000
20	60	54	14	4½x½	4.	2800	75	17000	2100	3300
22	60	54	15	5x½	4.3	3500	75	20000	2200	3500
24	60	60	16	6x½	5.1	3500	75	23000	2400	3700
26	72	66	16	6½ x½	5.5	3500	75	25000	2500	3700
28	72	72	20	7x½	5.8	3500	75	30000	3000	4500
30	72	72	20	8x½	6.9	3500	75	40000	3000	4500
36	96	96	25	8x½	6.9	4000	60	50000	4000	4750
48	120	120	30	8x¾	10.	6000	55	75000	4000	5000

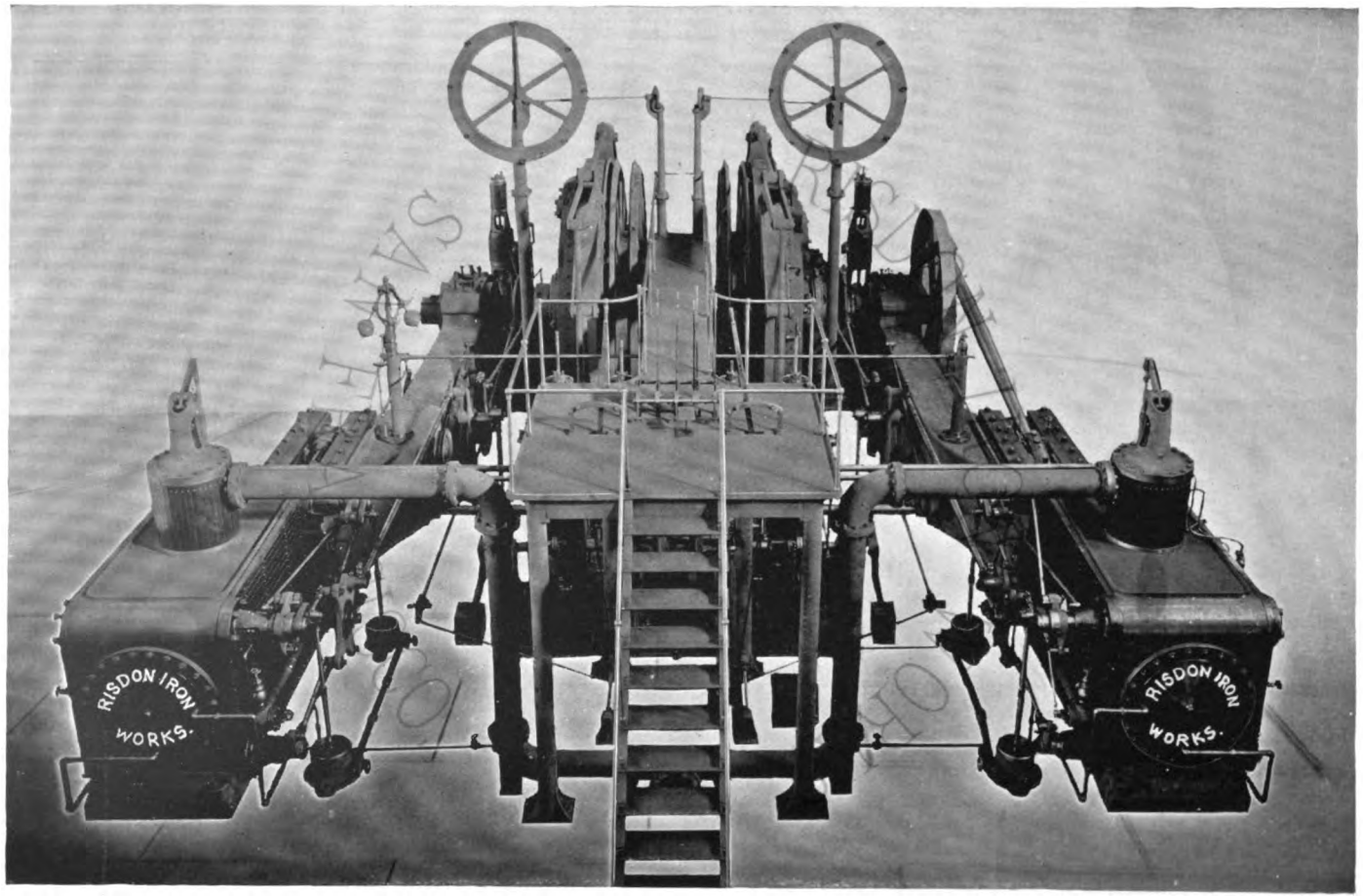
Strains on Rope figured on safety 5 to 6 and Plow steel.

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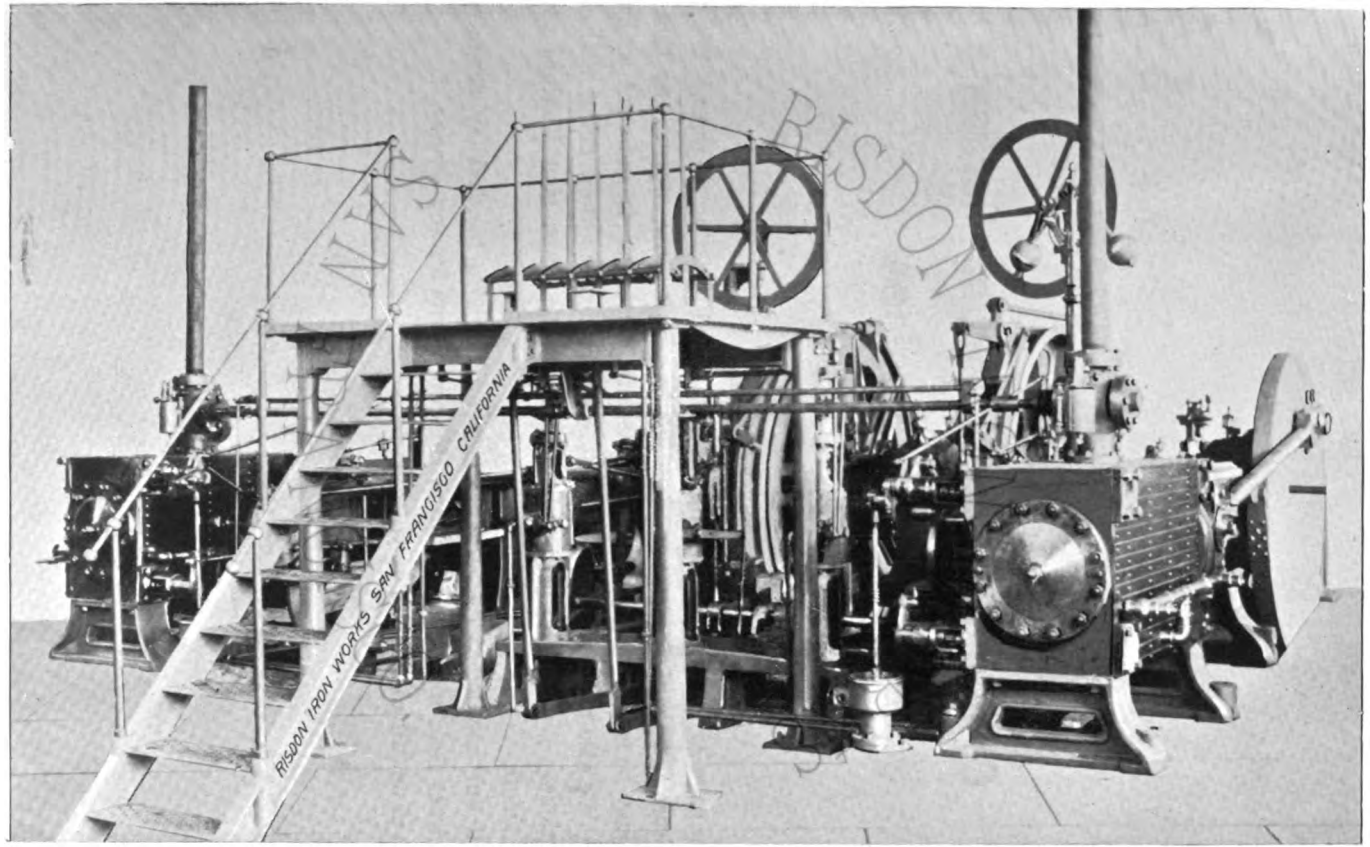
DOUBLE REEL DIRECT ACTING HOIST "FIRST MOTION" (Merced Pattern)

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DOUBLE REEL DIRECT ACTING HOIST, "FIRST MOTION (Anaconda Pattern)

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DOUBLE REEL DIRECT ACTING HOIST "FIRST MOTION" (Merced Pattern)

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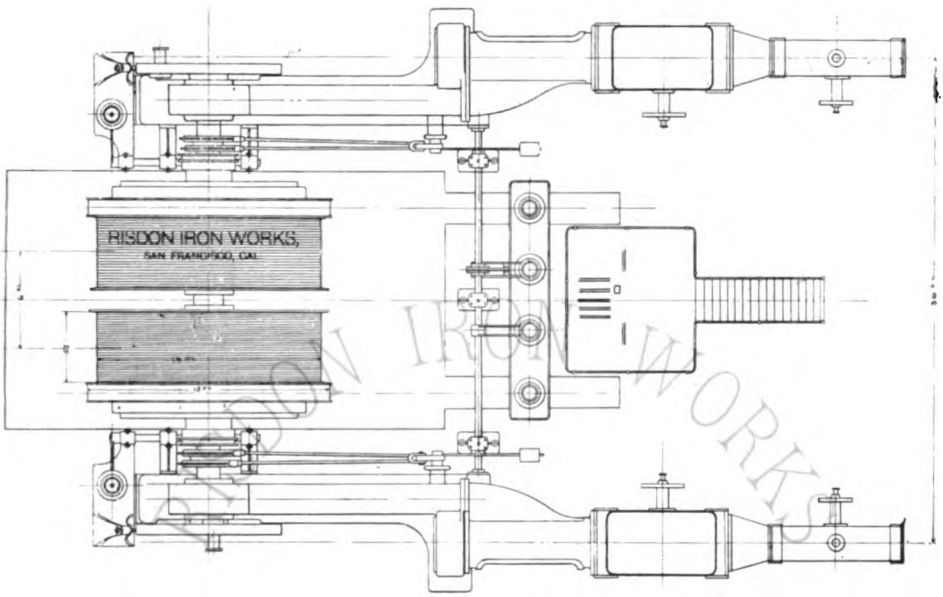
Compound Direct Acting Corliss Hoisting Engines

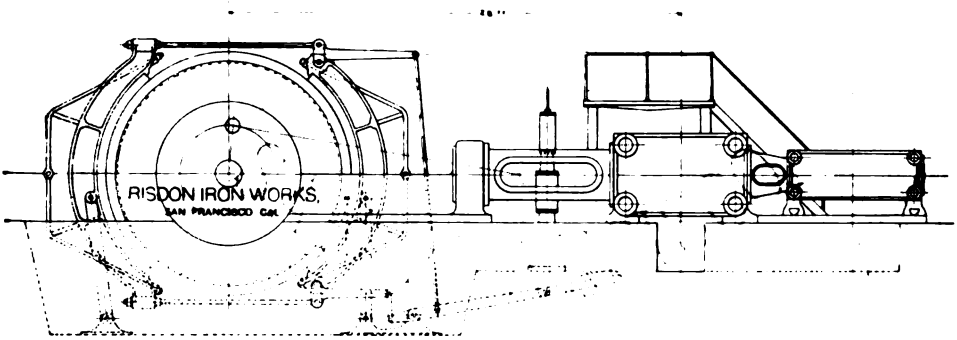
On page 41 we illustrate one of our Compound Hoisting Engines. We build both Cross and Tandem Compound, using by-pass to low pressure so that live steam may be used to start load before pressure in receiver is sufficient to handle work. We also build this style of hoist with vertical engines, using Bell crank connections. We are also prepared to build Triple Expansion Engines to suit requirements.

All our compound engines have operating parts handled by steam. We build either Reel or Drum Compound Hoisting plants for any service.

Send us full particulars of your wants.

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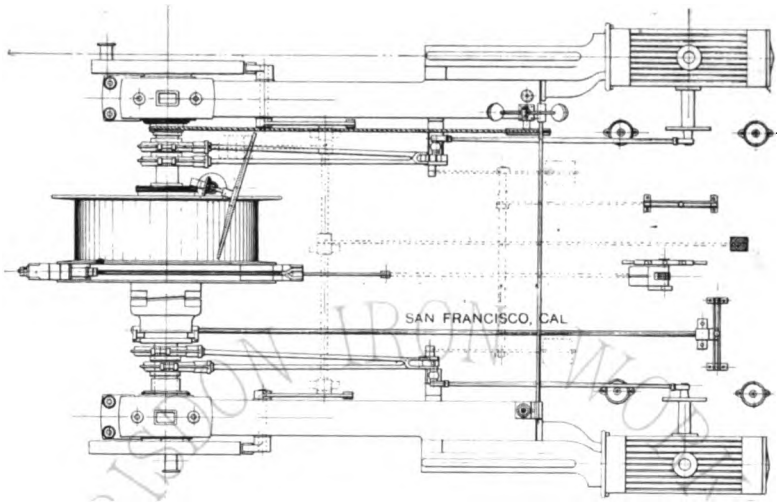


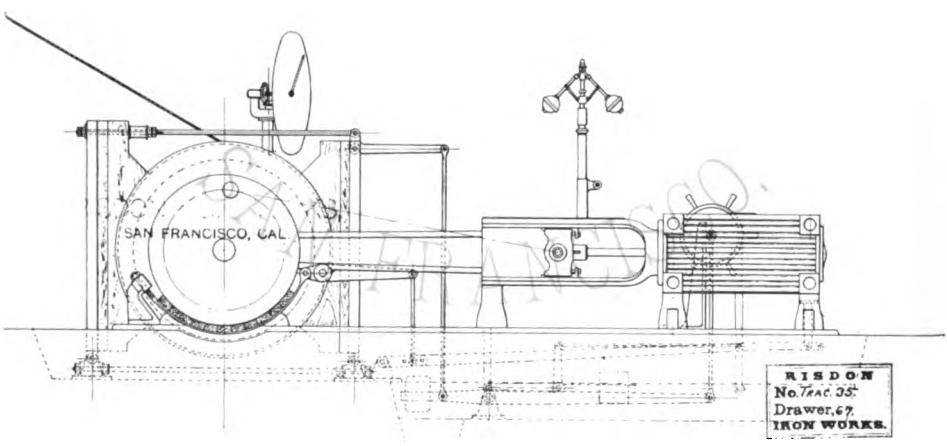
Double Drum, Compound, Direct Acting Hoist

(First Motion)

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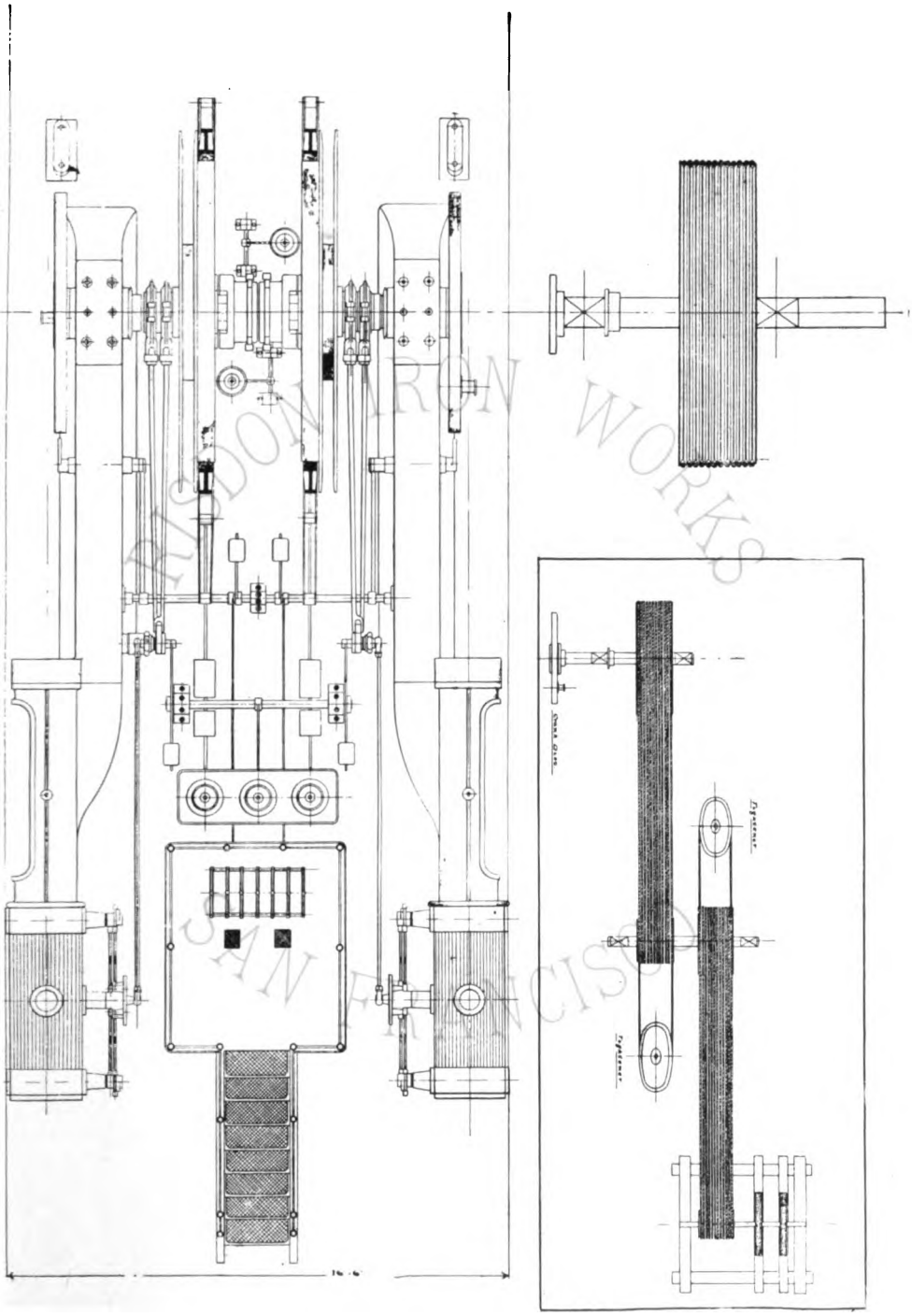




Single Drum Direct Acting Hoist

(Capacity—10 ton load from 3,000 feet depth)

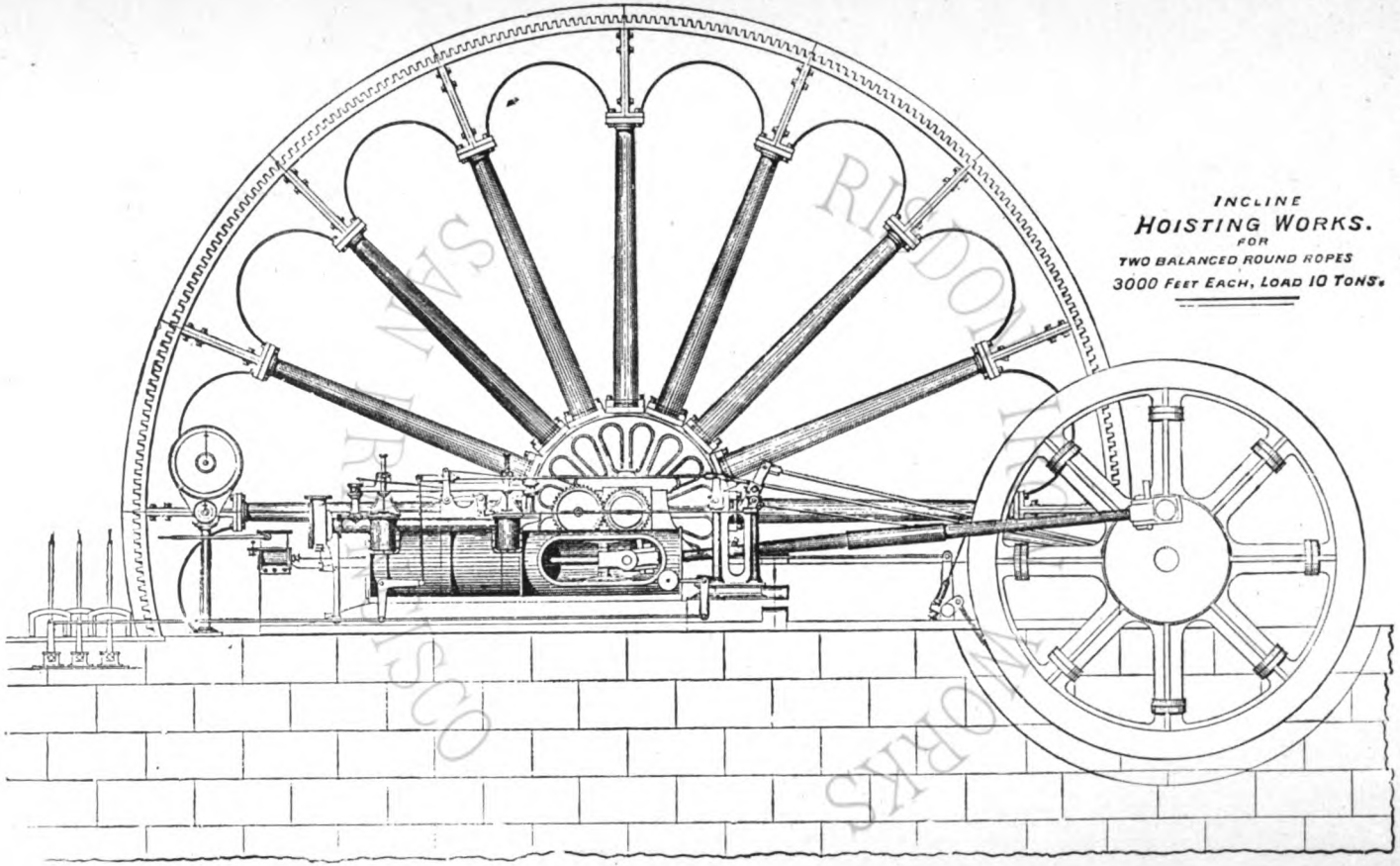
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Water Power Attachment to Steam Direct Acting Hoist

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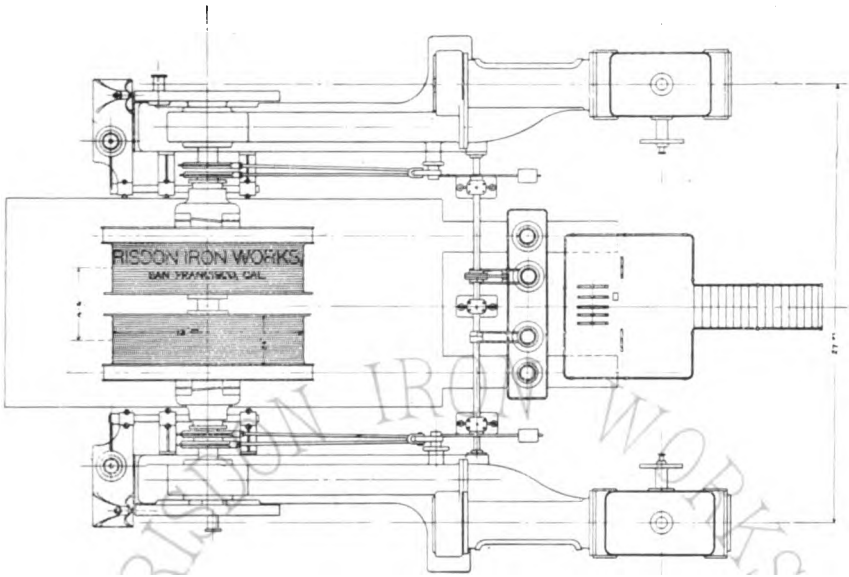
INCLINE
HOISTING WORKS.
FOR
TWO BALANCED ROUND ROPES
3000 FEET EACH, LOAD 10 TONS.

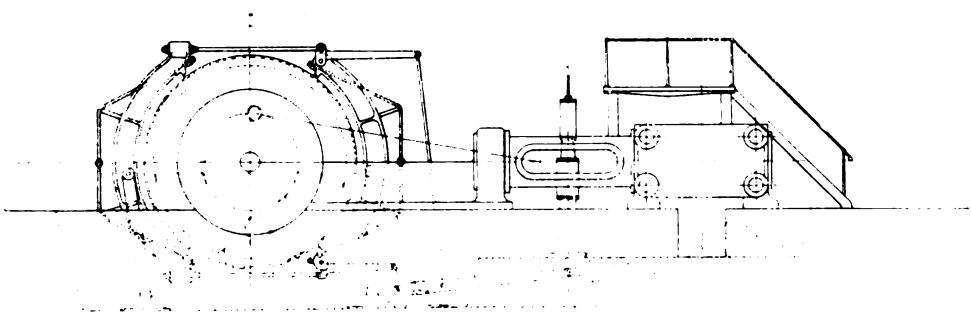
ELEVATION.

Single Drum Hoisting Engine with Geared Engines for very Large Loads and Great Depth. Largely used in Coal Mines.

The illustration is of hoist with 50 ft. diameter drum. One rope runs under, the other over and continually run in counter balance.

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Double Drum Direct Acting Hoist

(Lake Superior Type)

We build all sizes of the above type of engine with either Band Friction or Toe Clutches and are prepared to submit figures on plants of any dimentions.

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Double Cylinder, Single Reel or Drum, Double-Geared for Pump Compartments.

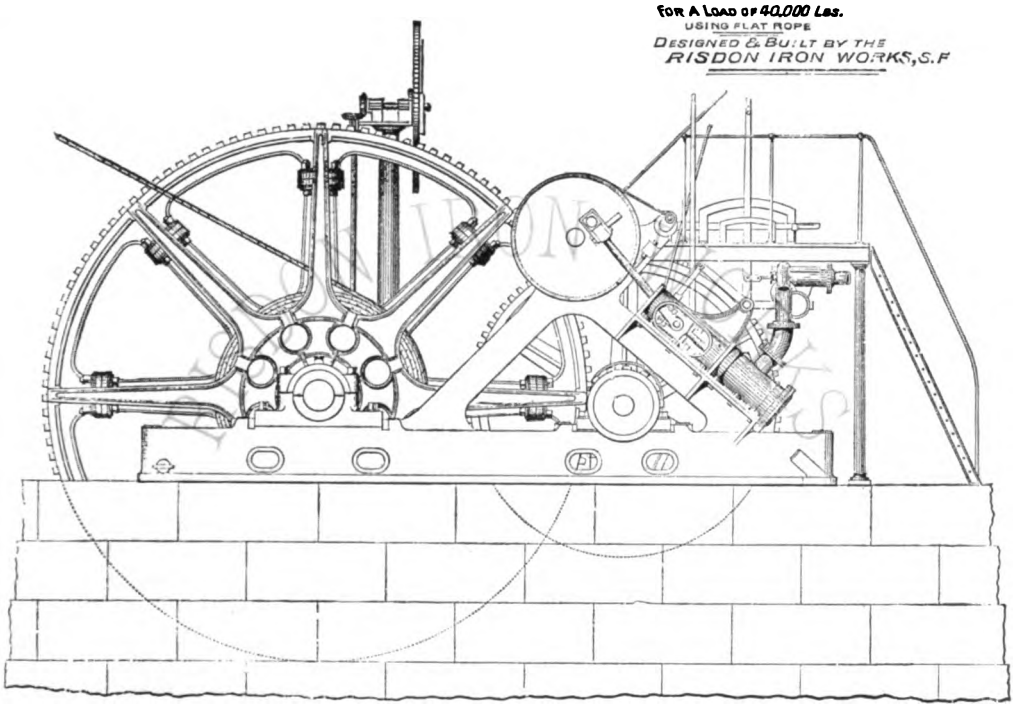
The style of hoist on page 47 is largely used in mines as an auxiliary man and timber hoist, and to lower heavy pieces of machinery. The speed is very slow, and pump rods, pumps and other machinery can be placed in the exact position required. The usual style is horizontal cylinders, but inclined and vertical cylinders are sometimes used.

The cut on opposite page is of an engine built by us for the famous Combination Shaft (Chollar Norcross & Savage Co.), Virginia City, and will handle a load of 20 tons or 40,000 lbs.

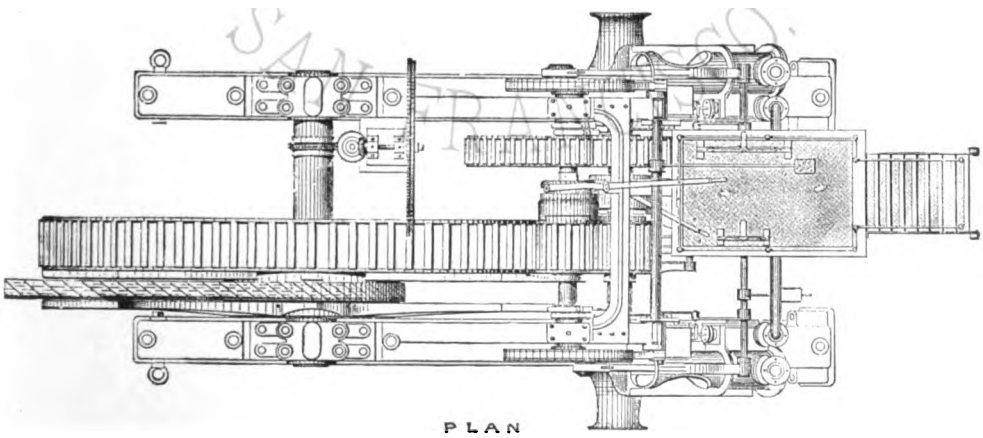
As a matter of safety all mines should have a man engine to use when men are working in shaft or when main engine is broken down or under repairs.

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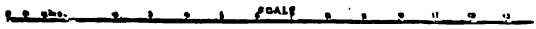
HOISTING WORKS,
FOR
PUMPING COMPARTMENT
FOR A LOAD OF 40,000 Lbs.
USING FLAT ROPE
DESIGNED & BUILT BY THE
RISDON IRON WORKS, S.F



SIDE ELEVATION.



PLAN



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Single and Double Drum Electric Hoists

We illustrate on pages 49 and 51 our Single Drum Electric Hoists, and we are prepared to build all sizes for either direct current or for alternating current. On page 52 we fully describe the construction of the electric apparatus.

We believe we were the first concern in the United States to use the "Tesla Polyphase Induction Motors" on our hoisting outfit. We have our hoists in practical use in several of the principal mines.

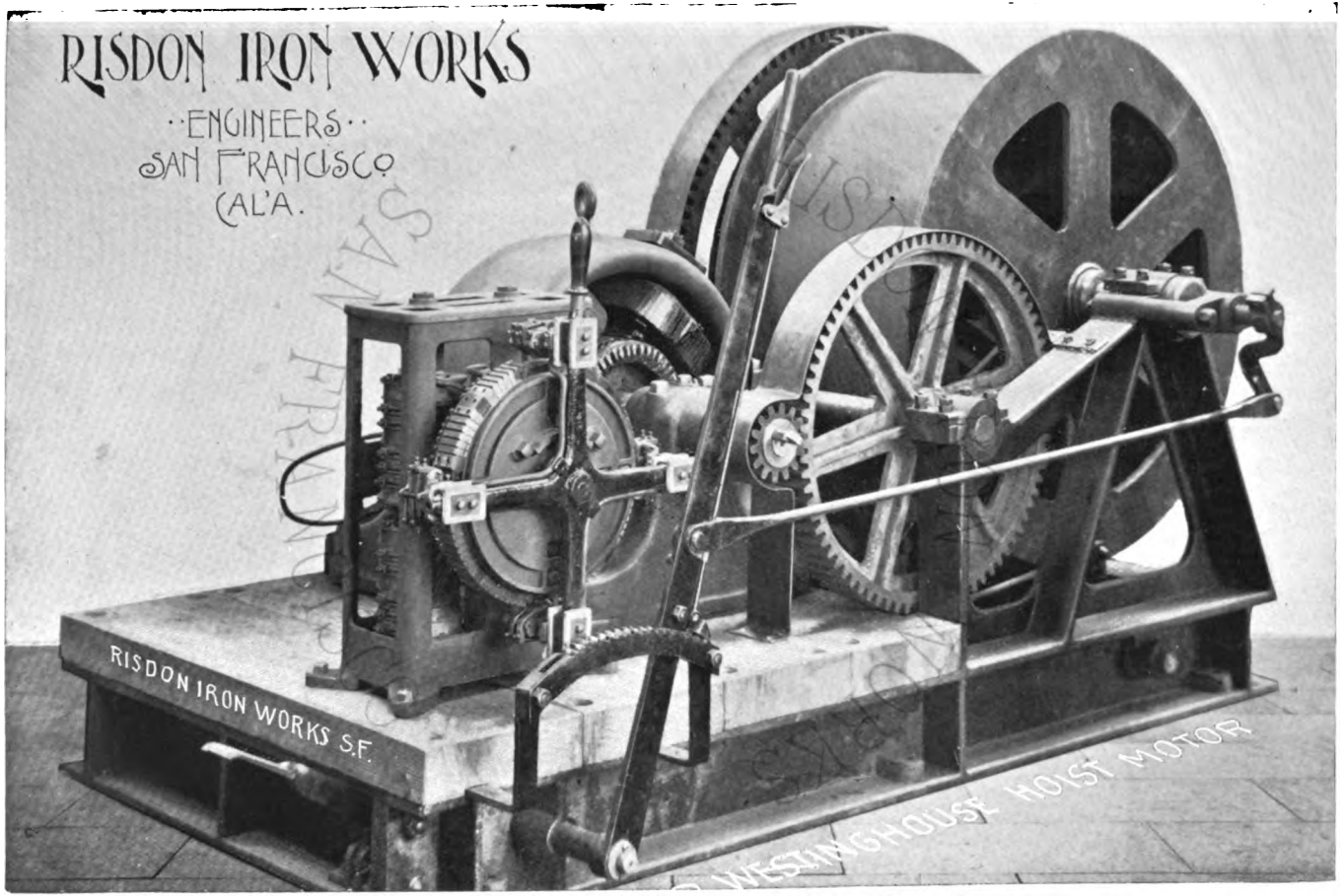
We build the following sizes for direct current:

Horse Power Motor	Approximate Load.	Average Speed per Minute.	Approximate Speed Motor
20	2500	200	1050 or 600
30	3500	200	975 " 600
40	4500	250	950 " 550
50	5500	250	900 " 550
60	5500	300	850
75	6000	300	850

Our pinions on motors are of best rawhide or cut steel.

Changes in speed and capacity made to suit requirements.

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SINGLE DRUM DIRECT CURRENT ELECTRIC HOIST

(We also build this style for alternating current.)

We will be pleased to furnish you estimates for operating your Mill, Hoists or Air Compressors by Electric Motors and for lighting your Mines

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LIST OF SIZES

OF

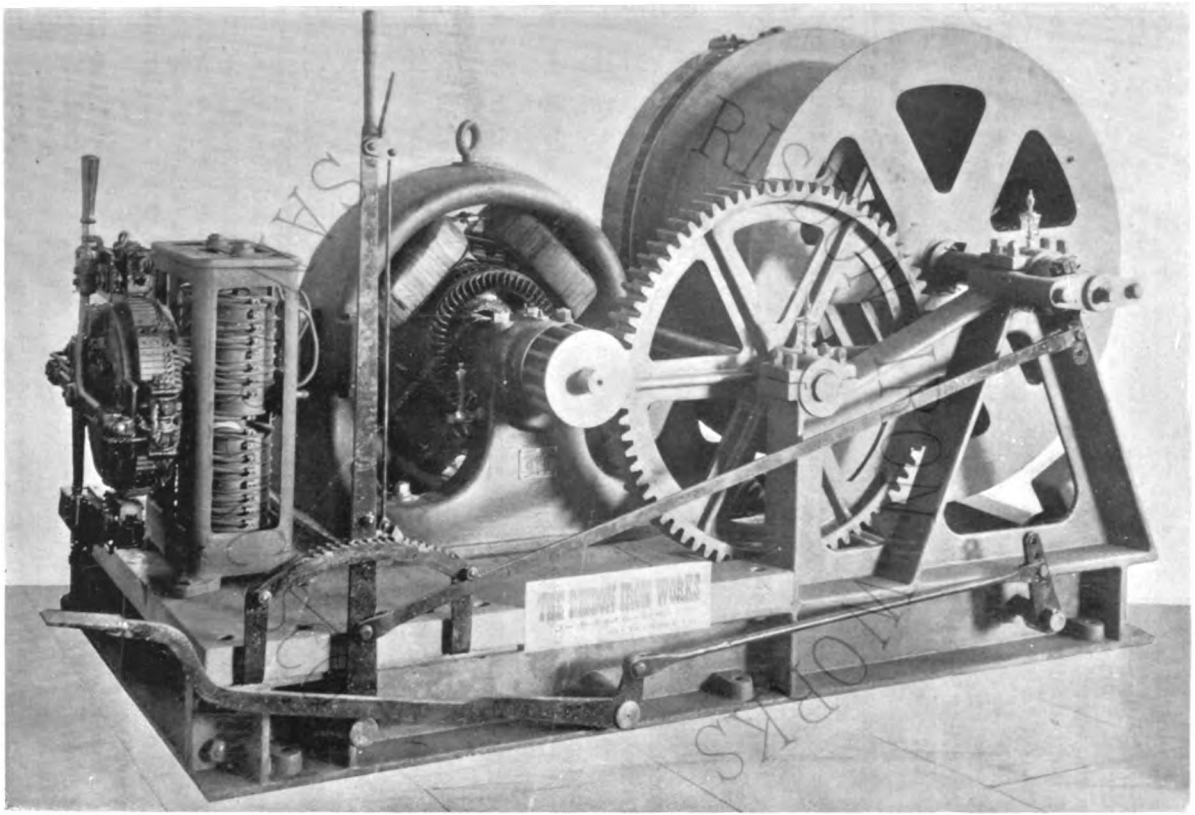
"Tesla Polyphase Induction Motors"

Used on Our Alternating Current Hoisting Outfits

Horse Power Motor	Approximate Load.	Average Speed per Minute.	Approximate Speed Motor
20	2500	200	1120
30	3500	200	845
40	4500	250	850
50	5500	250	850
75	6000	300	690
100	7000	350	580

Changes in speed and capacity made to suit requirements.

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Single Drum, Direct Current, Electric Hoist

(We also build this style for alternating current)

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THE ELECTRIC HOIST

Shown on pages 49 and 51 is for operation with direct current, and is used where the distance from the power supply is short—two miles is about the limiting distance for direct current.

The motor is directly geared to the hoist drum by a rawhide pinion and double reduction gear through the friction clutch. The friction clutch is operated by the hand lever at the right of the cut. It connects the hoist drum with the motor gearing. A brake of the regular band and wheel type is operated by a lever under the operators foot.

The motor operates in either direction. The speed and direction of rotation are easily controlled by the lever handle of the controller.

The Motor is of the regular direct current type and needs no special description here.

The Controller is used to form the connections from the power line to the motor. A direct current motor cannot be connected immediately on to the main circuit, as the current would be prohibitory and the starting too sudden. A resistance is necessary therefore, to be connected between the main circuit and the motor, its object being to reduce the voltage on the armature of the motor to an amount proportional to the speed required. This resistance is gradually cut out as the speed of the motor increases. The power is off when the handle is in its vertical position, and the operation of starting in either direction is a slow movement forward or backward to such a point as gives the desired speed.

These motors are run in all locations, above ground or in mine drifts.

We also build our electric hoists, operated by Tesla Induction Motors. This motor is operated with the alternating current system, and is used in all cases where the distance is long or the required economy of power is important. These hoists are in every way similiar to the regular mining hoists, except in the motor itself and in the controller.

The motor is geared to the hoist in the usual manner employed for steam engines or water wheels.

The alternating current hoist has several decided advantages over the direct current hoist:

1st. The current can be transmitted from the power supply to the hoist at a high voltage and transformed to the working voltage by the regular static transformers, which require no attention.

2nd. The motor has no brushes or commutator, or collector rings, the only wearing part being the self-oiling bearings.

3rd. The rotating part of the motor is composed of a laminated iron ring mounted on a cast steel spider with a short circuit squirrel cage winding. It being permanently and purposely short circuited, there is no danger of injury to the rotating part of the motor, by short circuit from dampness or mechanical injury, and no ordinary amount of dust can effect the operation of the motor.

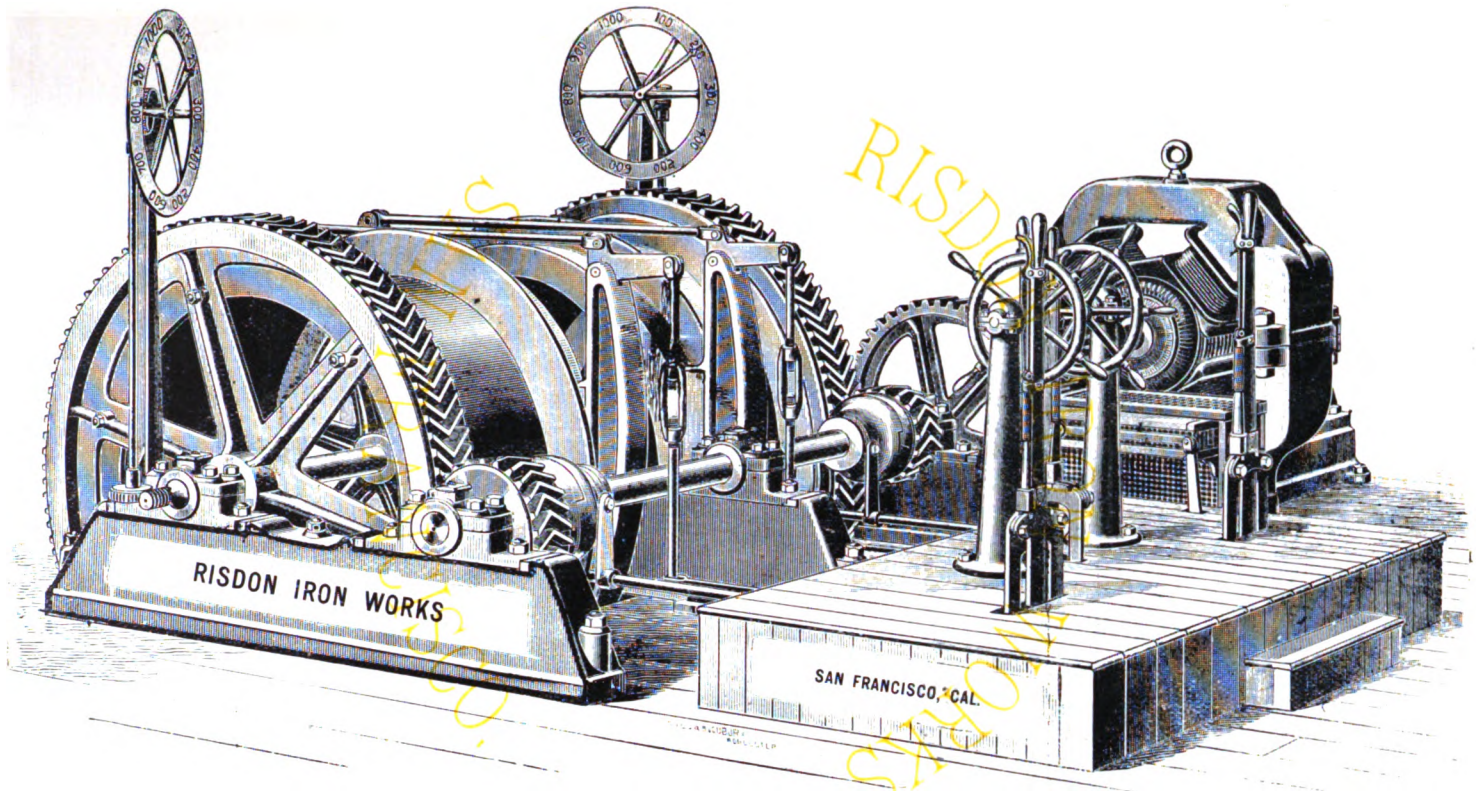
4th. With alternating current the conversion from one voltage to any desired voltage is so simple that the operation of a variable speed motor can be accomplished without the resistance needed for direct current work.

This is done by a series of conversions of different ratios and the proper switching device. All of the power taken from the line is thus used to operate the motor and not dissipated in resistance as is the case with a direct current motor. The voltage applied to the motor and the speed of it are controlled at will by the position of the lever in the hands of the operator.

5th. The motor can be used in a reversed position as a brake, when it will operate as a generator and supply current to the main line. The motor will do this with no more wear and tear than is obtained when running as a motor.

6th. The power taken from the line in the direct current hoist is proportional to the torque-lifting stress, and independent of the speed of the skip, the power going into the resistance, if the speed is low. With the alternating current hoist power taken from the line is proportional to the work done—lifting stress multiplied by the speed of the skip, and no power is lost in resistance.

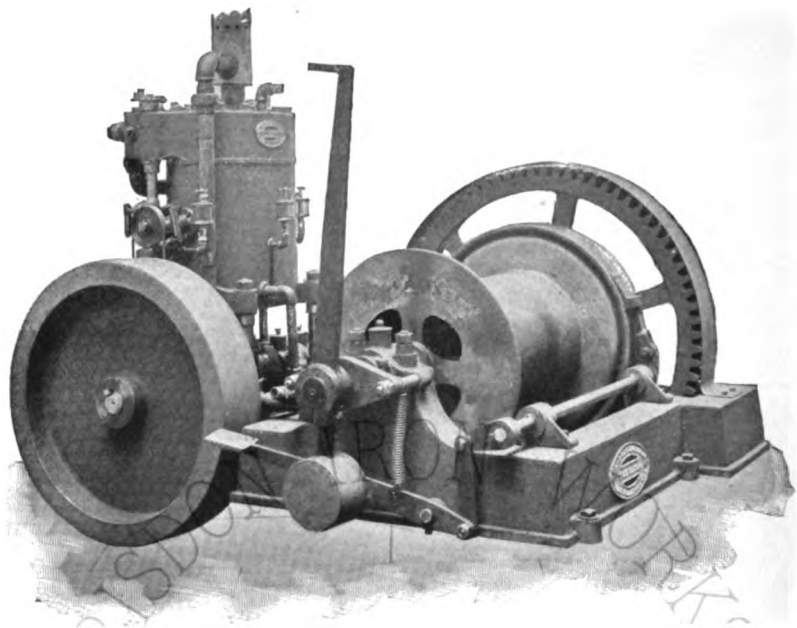
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DOUBLE-DRUM ELECTRIC HOIST.

(Alternating or Direct Current as required.)

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Gas or Gasoline Hoisting Engine

The above cut represents our ten h. p. double cylinder engine of latest type, and hoist combined, on strong iron base. This hoist is designed to raise one ton 125 feet per minute from an inclined shaft, or 1500 pounds at the same speed vertical lift. The drum will hold over 600 feet of 5/8 inch cable. The outfit weighs 3500 pounds.

Fitted to run on either Stove Gasoline (Naphtha or Benzine) or Distillate.

Started instantly. Compact, strong, simple, efficient, economical. Perfectly governed, so that the oil is used only in proportion to the work done. No expense when idle.

Particularly adapted to mining and ship and wharf use, and in sections where wood, coal and water are expensive.

We use the well known Union Gas Engine on above hoist.

Built in the following sizes: 6 h. p. Friction Hoists, 10 h. p., 20 h. p., 30 h. p., 40 h. p., as shone in cut.

Write for prices, stating Horse Power or service required.

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ORE BUCKETS

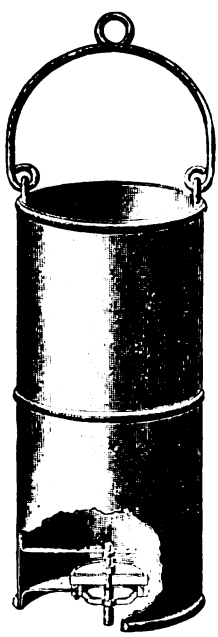
This cut represents one style of Ore Bucket which we build, and is designed for use in either vertical or inclined shafts, the barrel-shaped ends and countersunk rivets allowing the bucket to slide smoothly along slides or on any object with which it may come in contact. We also make these buckets with parallel sides and half-round bands, as shown in cut of water bucket below. We give a separate table of prices and weights for this style.



TABLE OF STANDARD SIZES.

	ORE BUCKETS WITH TAPERED ENDS, AS IN CUT				ORE BUCKETS WITH PARALLEL SIDES AND BANDS			
No.	Diam	Hgt	Wgt	Capac'y Pounds of Ore	Diam	Hgt	Wgt	Capac'y Pounds of Ore
1	18	24	70	350	18	24	80	350
2	20	26	95	470	20	26	105	470
3	22	28	130	620	22	28	145	620
4	24	30	155	780	24	30	160	780
5	26	32	205	980	26	32	225	980
6	28	34	256	1200	28	34	280	1200
7	30	36	290	1450	30	36	325	1450
8	32	38	340	1700	32	38	380	1700
9	36	40	500	2300	36	40	550	2300

WATER BUCKETS



This cut shows our water bucket for use in vertical shafts. It is furnished either with chains or bale, as shown in cut. The valves are of rubber, re-enforced top and bottom, with wrought-iron plates; stem is well guided and projects sufficiently below bottom to open valve when lowered in discharging sluice.

TABLE OF STANDARD SIZES.

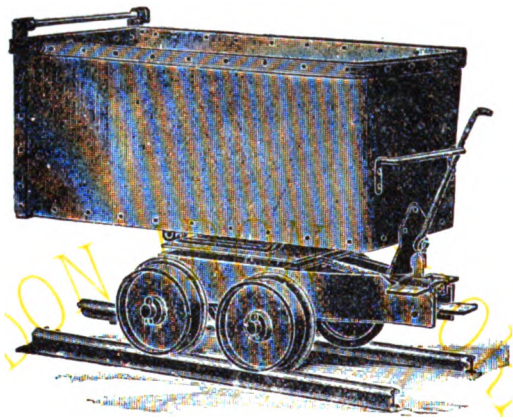
No.	Diameter	Height	Weight	Capacity, Gallons
1	18	36	120	40
2	20	40	145	54
3	22	44	190	71
4	24	48	210	93
5	26	52	300	115
6	28	56	390	150
7	30	60	470	183
8	32	66	630	229
9	36	72	740	317
10	36	78	800	370

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RISDON IRON AND LOCOMOTIVE WORKS

SAN FRANCISCO, CAL.

STEEL MINING CARS.



STYLE A

NO.	DIMENSIONS IN INCHES.			THICKNESS.		CAPACITY	Diam. of Wheels.	Weight.	SIZE AXLE.	PRICE.
	Width.	Depth.	Length.	Sides.	Bottoms.	Cubic Feet.				
1	16	18	30	14	14	5	8	310	1 1/4	$38
2	18	24	36	14	12	9	10	350	1 1/4	40
3	24	21	44	14	12	12	10	380	1 1/4	45
4	24	21	44	12	12	12	10	420	1 1/4	50
5	24	21	44	12	10	12	10	475	1 1/4	60
6	22	24	40	12	10	12	10	600	1 1/2	72
7	24	24	42	12	10	14	10	650	1 1/2	80
8	24	25	48	6	4	16	12	590	1 1/2	75
9	26	24	44	6	4	16	12	700	2	84
10	26	24	48	6	4	17 1/2	12	750	2	90
11	30	25	48	4	4	20	12	685	2	85
12	28	26	48	4	4	20	12	800	2	96
13	30	26	64	4	4	22 1/2	12	850	2	100
14	36	30	72	4	4	45	12	1500	2 1/2	175

Can be dumped end or side; built to run on 18 inch track; 20 cubic feet broken quartz, 1 ton; 18 cubic feet gravel in bank, 1 ton.

We manufacture special sizes and shapes of bodies as well as axles, boxes and wheels, as may be required. All our cars are very substantially made and built of best quality of material.

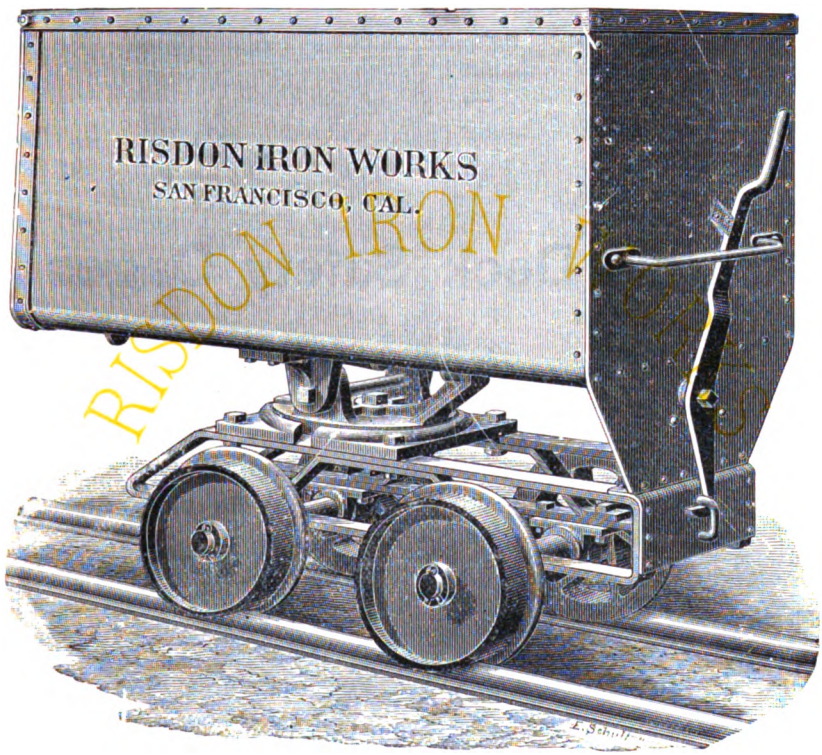
We also manufacture all kinds of Self-Dumping Skips.

ALL KINDS OF MINING and MILLING MACHINERY.

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MINING CARS

The following cut represents a Side and End-Dumping Mining Car. The door is hinged, and the catch which holds it and that which locks the box in position, are operated by one lever.



STANDARD SIZES

No.	Dimensions of Box in Inches			Contents in Cubic Feet	Gauge of Track in Inches	Diam. of Wheels in Inches	Weight in Pounds	Price
	Width	Depth	Length					
1	18	24	36	9	18	10	500	$ 70 00
2	20	24	42	12	18	10	575	80 00
3	24	24	42	14	18	10	650	90 00
4	24	24	48	16	18	12	780	100 00
5	24	26	48	17	18	12	800	105 00
6	26	26	48	18	18	12	850	110 00
7	26	28	48	20	18	12	900	115 00

We manufacture special sizes and shapes of bodies, as well as special axles, boxes and wheels, as may be required.

We also manufacture wooden bodies, with or without iron lining.

All our cars have chilled wheels and are very substantially built of steel plates.

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Single Deck Safety Cages

We illustrate one of our Safety Cages, made of best forged steel or Norway iron, which is without doubt the best cage on the market today.

The uprights are made with slot so that bolts in guides can be examined from time to time.

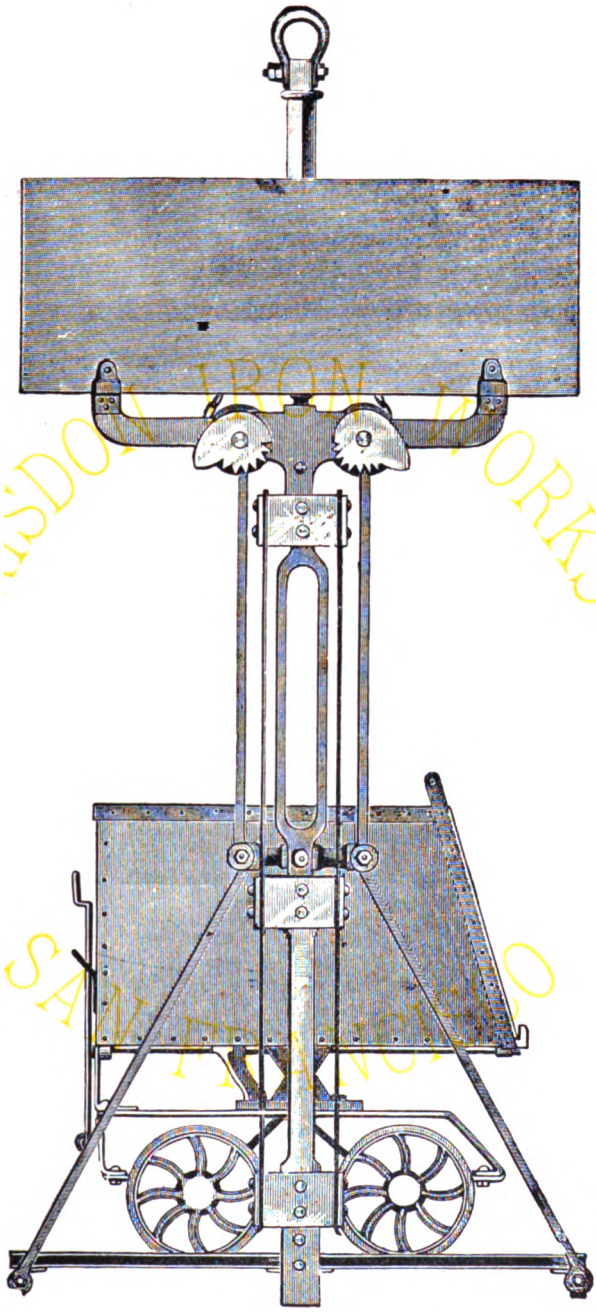
The hood is hinged, so that when long timbers are to be handled no difficulty will be experienced.

The safety catches are thoroughly trustworthy, and automatically adjust themselves to guides in case of accident.

Our Double Deck Cages are constructed on same lines. We also build cages for incline shafts with adjustable or stationary platform.

For weights and sizes see page 60.

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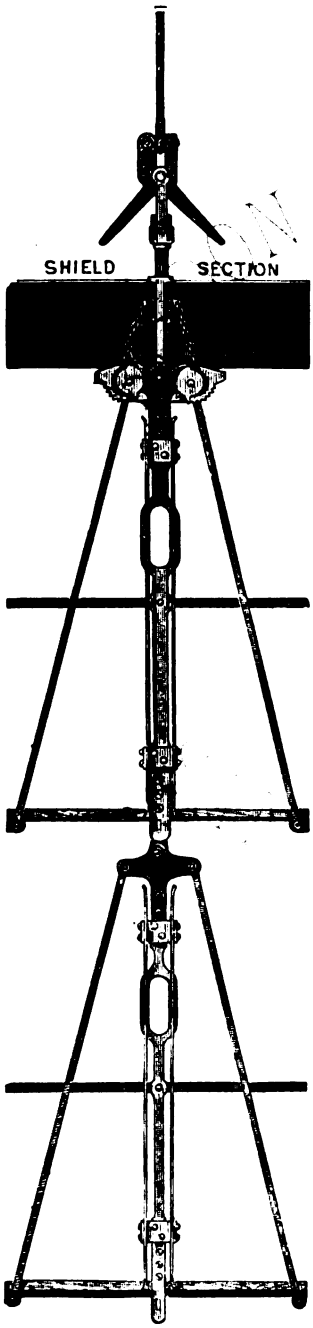


Single Deck Safety Cage with Hinged Hood of Forged Steel or Norway Iron

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Double Deck Safety Cages

(We also build this style with 4 and 6 decks)



LIST OF STANDARD SIZES

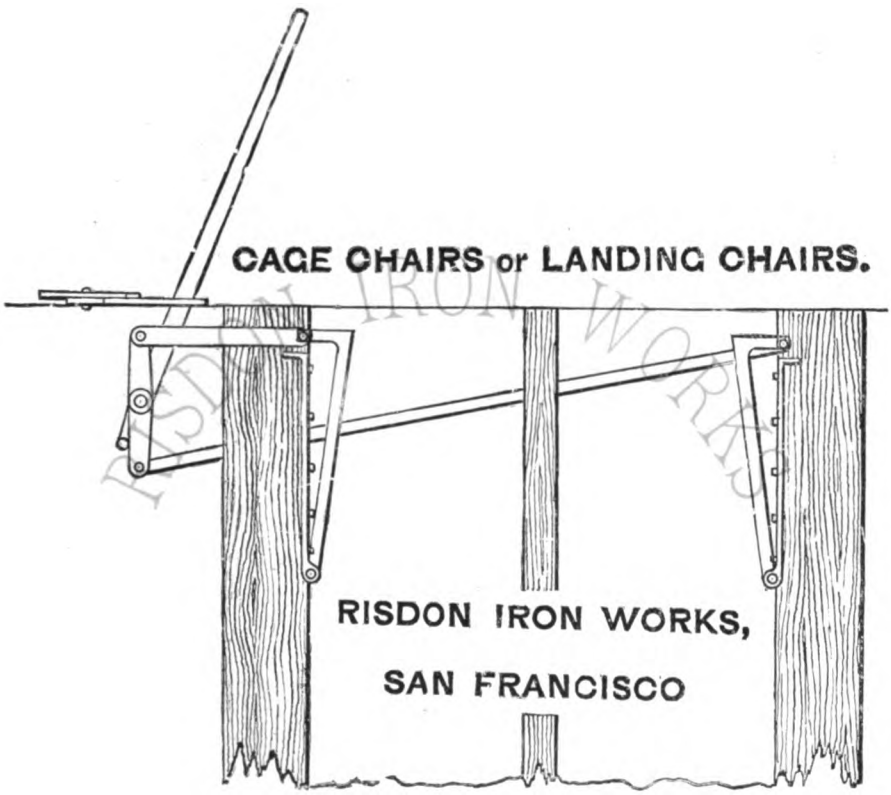
Width	Length	Height	
		Single Deck	Double Deck
30	42	84	140 in.
36	48	96	168 in.
44	52	96	168 in.

Weight		
Single Deck	Double Deck	With Sinking Guides Add.
750 pounds	1250 pounds	400 pounds
900 pounds	1450 pounds	400 pounds
1150 pounds	1900 pounds	400 pounds

SPECIAL CAGES UP TO 4 DECKS BUILT TO ORDER

We also build Angle Iron Cages when a cheap, light cage is required for temporary purposes

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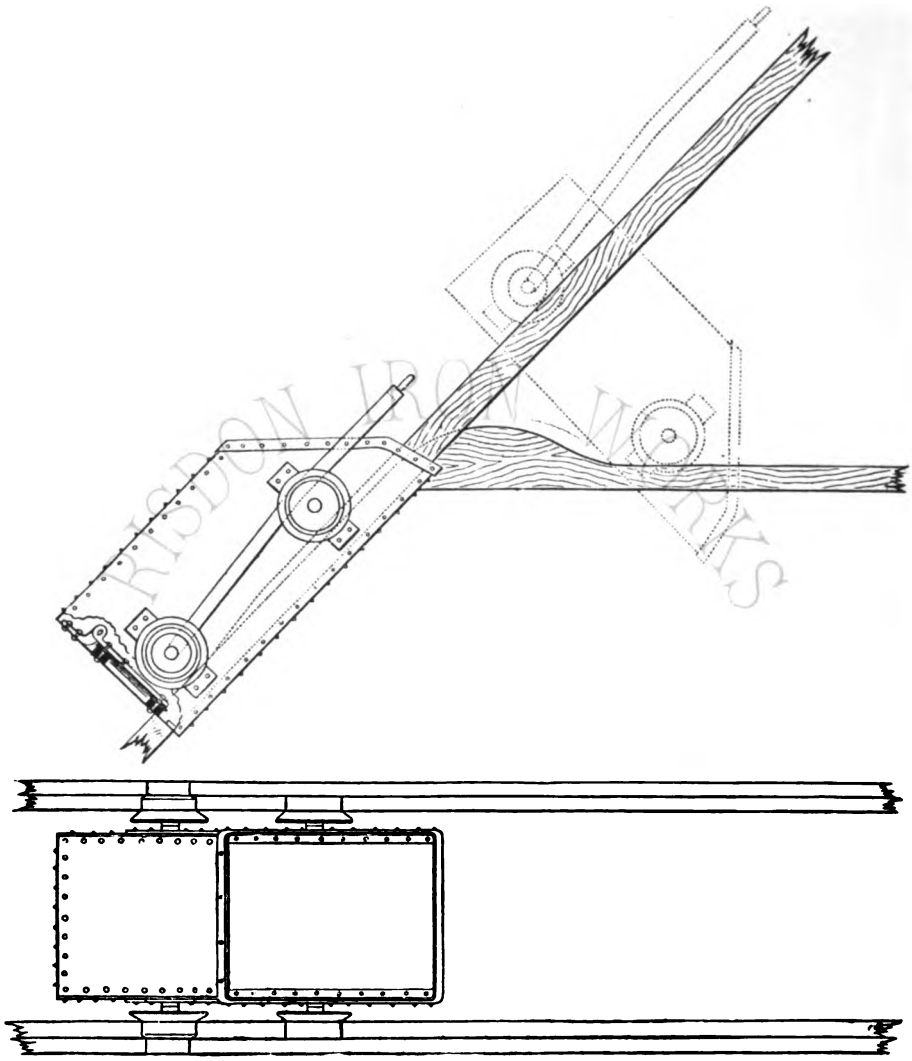


We build three sizes to suit standard size cages. They weigh 300, 350 and 400 pounds per set.

Cage chairs or landing dogs are devices for supporting hoisting cages while loading and unloading. The surface ones are automatic in always being in a position to receive the cage. All underground have to be placed in fastener under the cage when loading or unloading, at other times they are held back automatically.

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Self-Dumping Ore or Water Skip for Inclines.



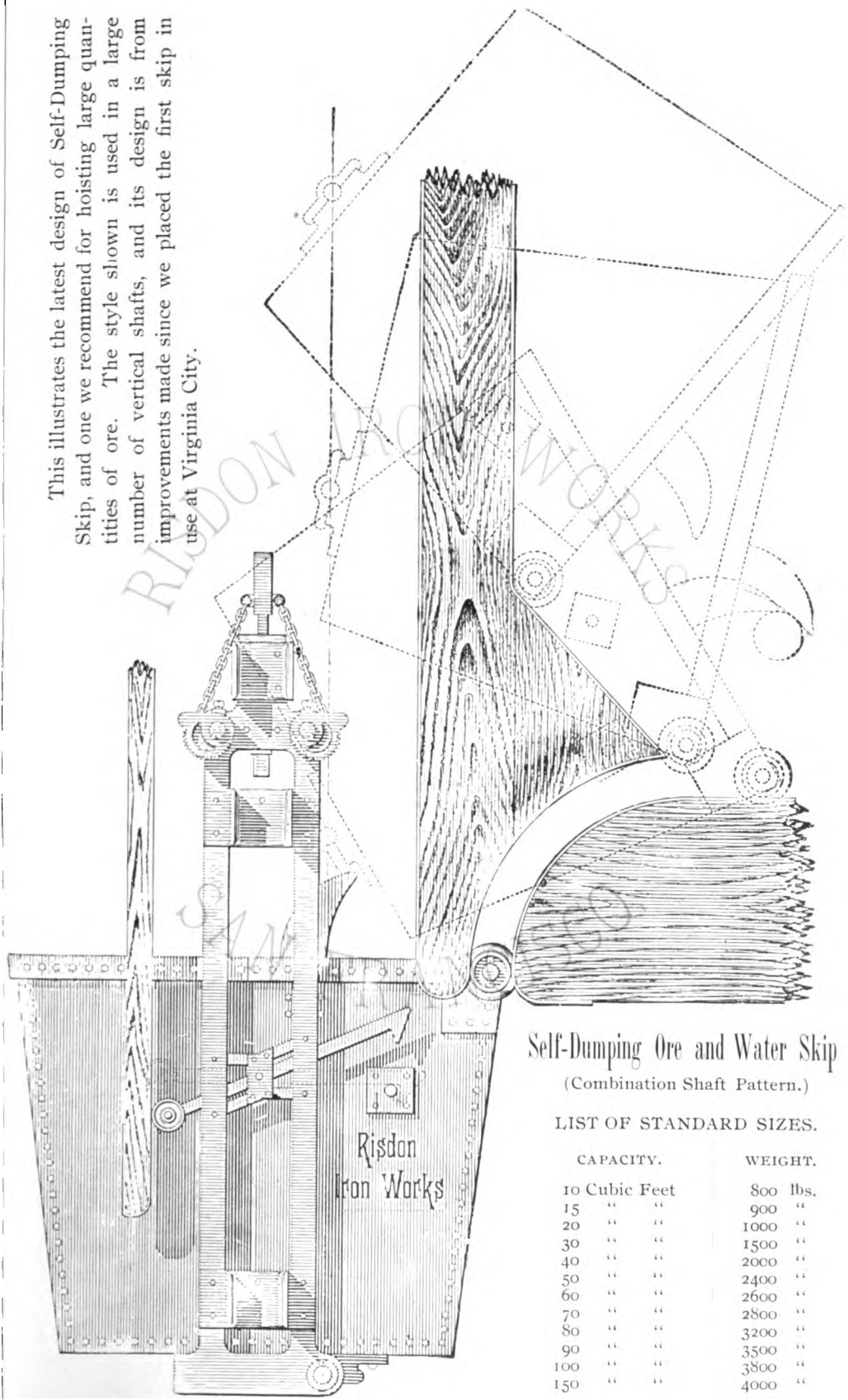
The above cut represents our self-dumping incline skip, designed for use in small inclines where space is limited. The cut represents a water skip. Ore skips are the same but without the valve in bottom.

TABLE OF STANDARD SIZES.

	DIMENSIONS.				TRACK GAUGE	WGT	ORE SKIPS		WATER SKIPS	
No	Width	Height	Length Top	Length Bottom			Capacity Cubic Ft	Price	Capacity Gallons	Price
1	20	20	36	48	24	500	10	$ 90.00	62	$110.00
2	24	24	48	54	30	700	15	125.00	120	150.00
3	26	26	54	60	32	900	20	165.00	160	190.00
4	30	30	54	66	36	1250	30	250.00	225	300.00
5	36	36	66	72	42	1650	40	330.00	300	400.00

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This illustrates the latest design of Self-Dumping Skip, and one we recommend for hoisting large quantities of ore. The style shown is used in a large number of vertical shafts, and its design is from improvements made since we placed the first skip in use at Virginia City.



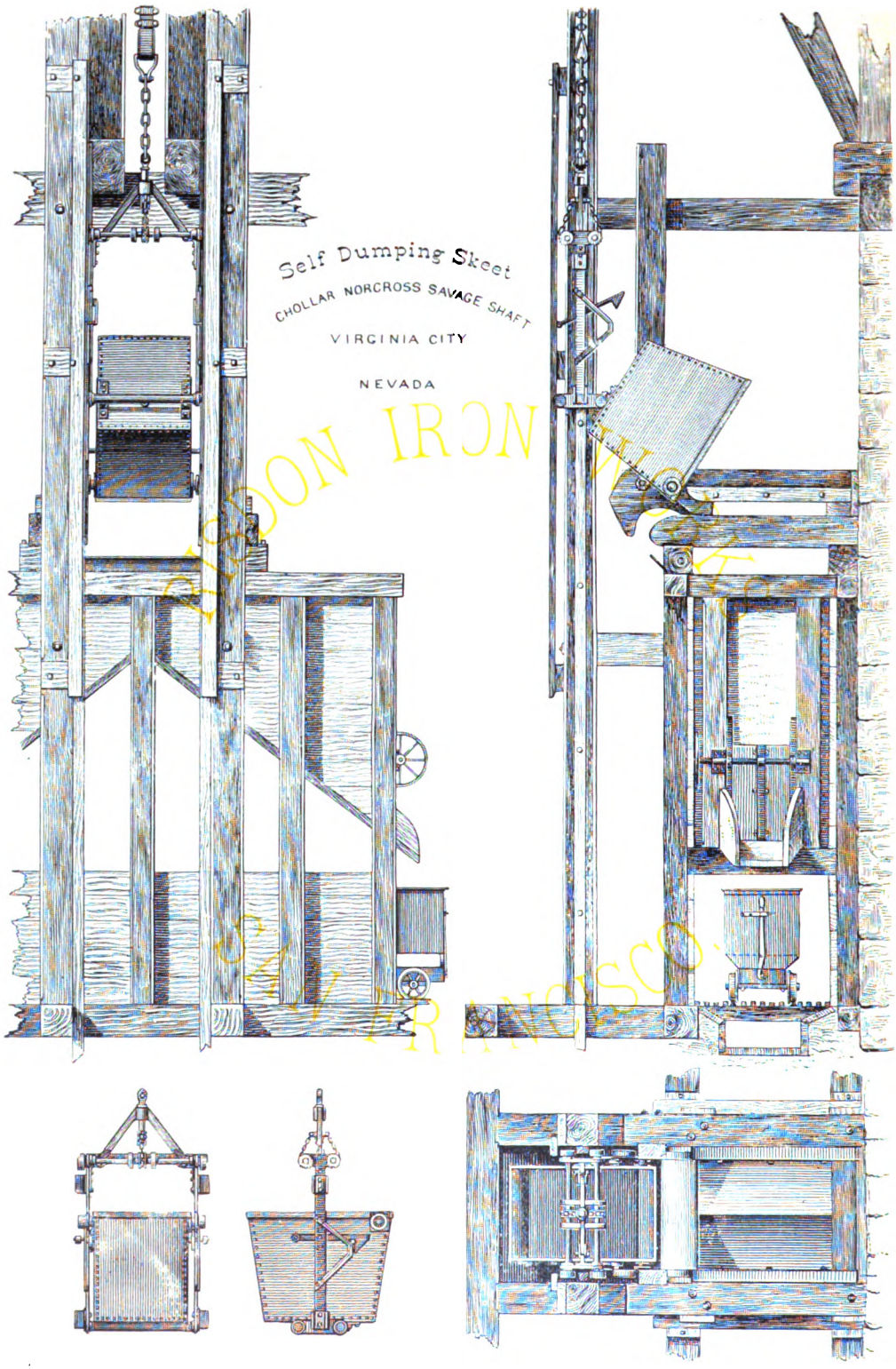
Self-Dumping Ore and Water Skip

(Combination Shaft Pattern.)

LIST OF STANDARD SIZES.

CAPACITY.	WEIGHT.
10 Cubic Feet	800 lbs.
15 " "	900 "
20 " "	1000 "
30 " "	1500 "
40 " "	2000 "
50 " "	2400 "
60 " "	2600 "
70 " "	2800 "
80 " "	3200 "
90 " "	3500 "
100 " "	3800 "
150 " "	4000 "

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THE FIRST SELF-DUMPING SKIP MADE ON THE PACIFIC COAST

BUILT BY RISDON IRON WORKS

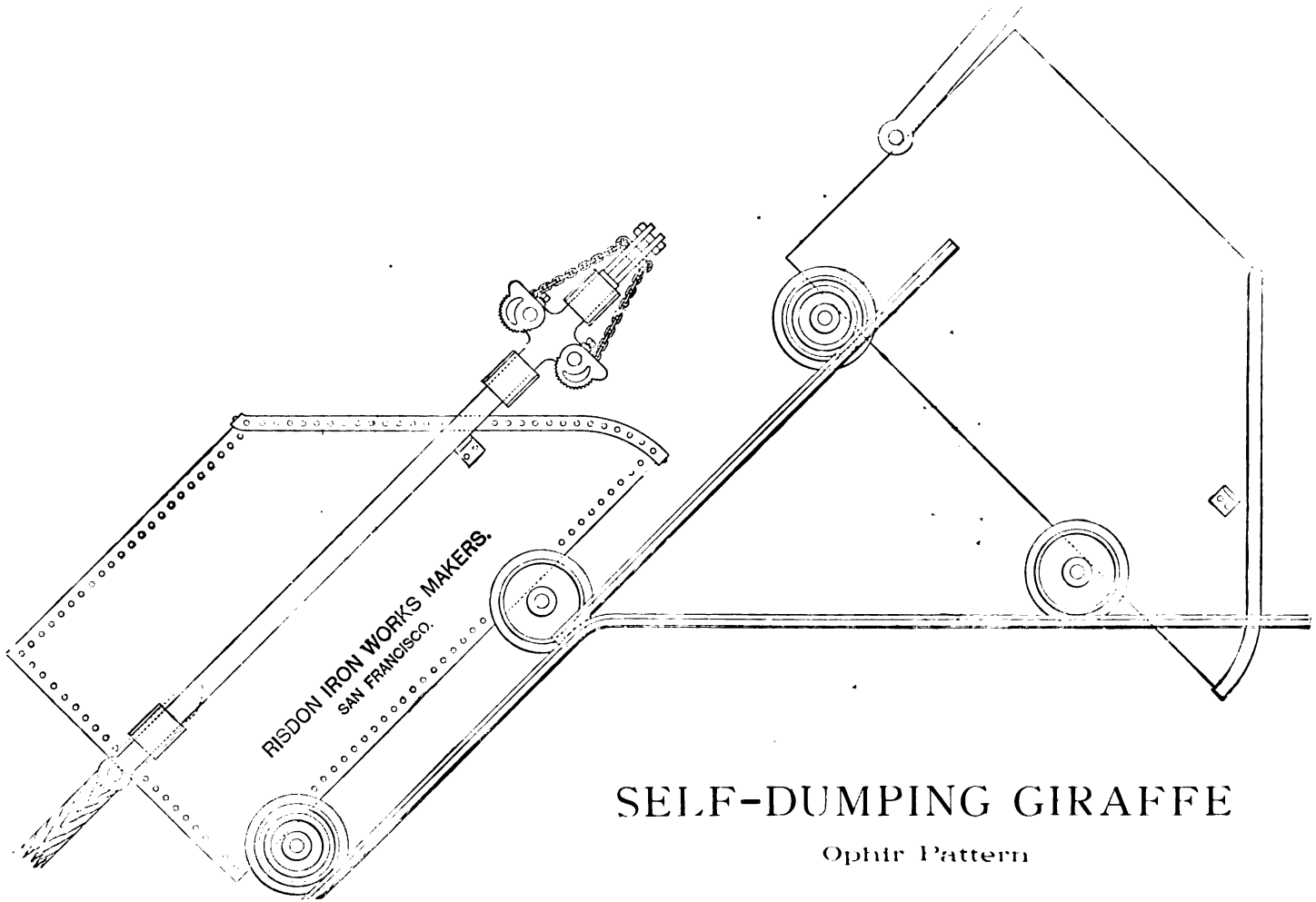
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OUR SELF-DUMPING GIRAFFE

This is a very useful appliance in mines when the shaft is sunk some distance from the outcrop of ledge, and if same is very shallow, the usual manner of exploiting is to sink vertical shaft. If the dip of ledge should continue at the same pitch after having been intersected by shaft, the ledge is sometimes followed to avoid the long drifts or levels which would be necessary if vertical shaft was continued. The Giraffe then becomes a necessity owing to its flexibility, and will run up the incline shaft until reaching the vertical, then the wheel acts as part of the guides and the safety catches are ready to operate during trip up vertical shaft.

Sizes are the same as those given on pages 62 and 63.

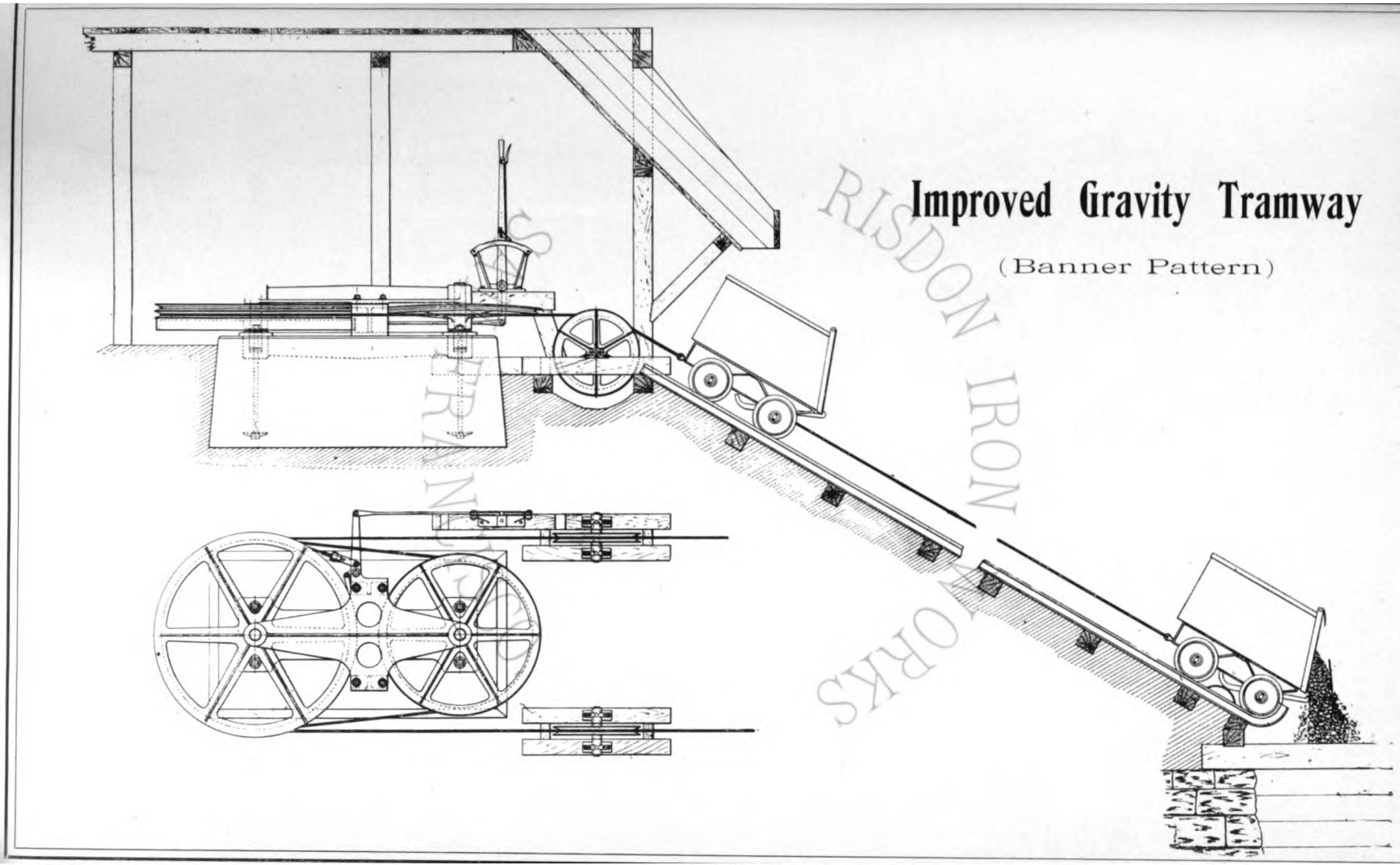
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SELF-DUMPING GIRAFFE

Ophir Pattern

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Improved Gravity Tramway

(Banner Pattern)

RISDON IRON WORKS
SAN FRANCISCO

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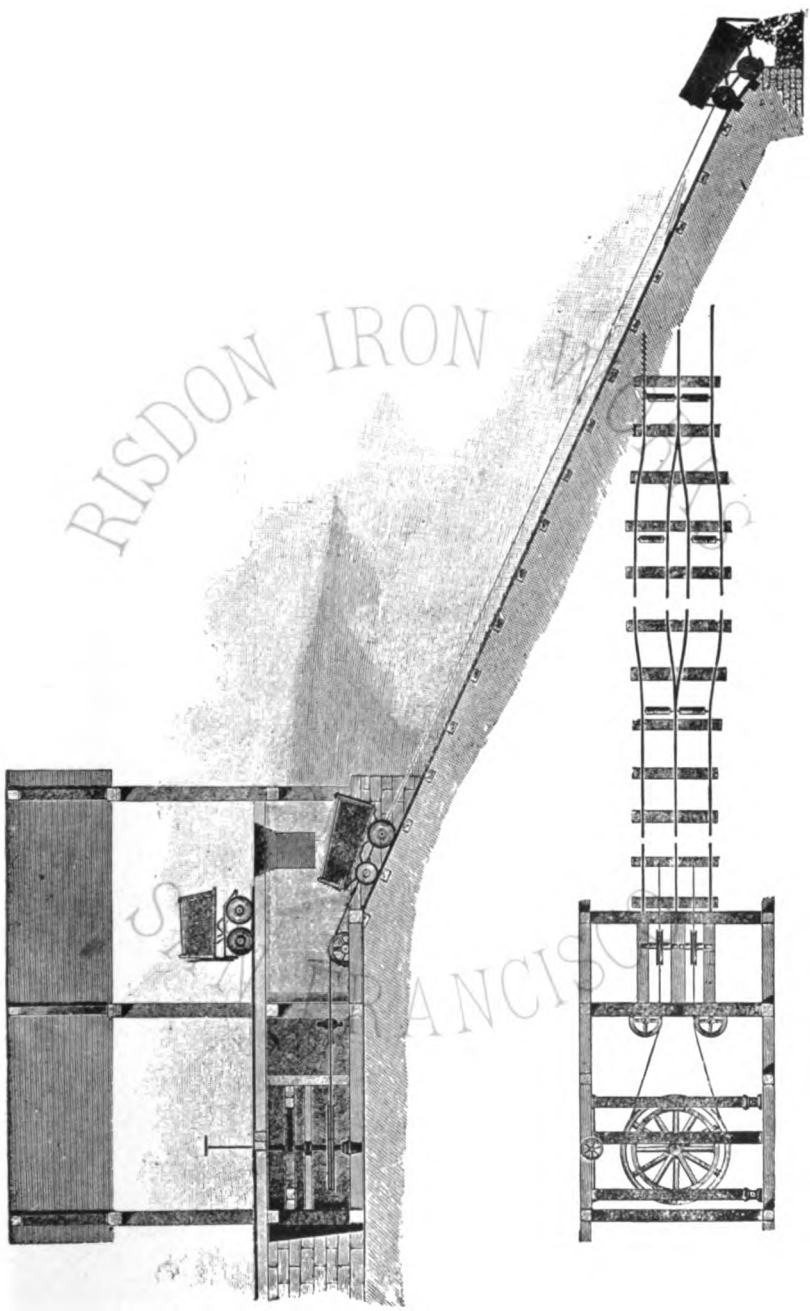
INCLINE GRAVITY TRAMWAY

On the opposite page we illustrate our Gravity Tramway, largely used in mines on this coast. The weight of the loaded car hauls up the empty car, and only one man is required to handle the Tramway.

A three-rail track is used, and at the bottom a self-dumping stop is put in. Speed is controlled by operator at the upper end. We build two styles. Page 69 illustrates the simplest form. The weight is about 2500 lbs., which includes 1 upper brake wheel and sheave, 4 guide sheaves, all shafting and boxes, and the necessary levers and bolts.

Our improved double sheave system illustrated on page 67 is a very substantial rig, and weighs about 4000 lbs.

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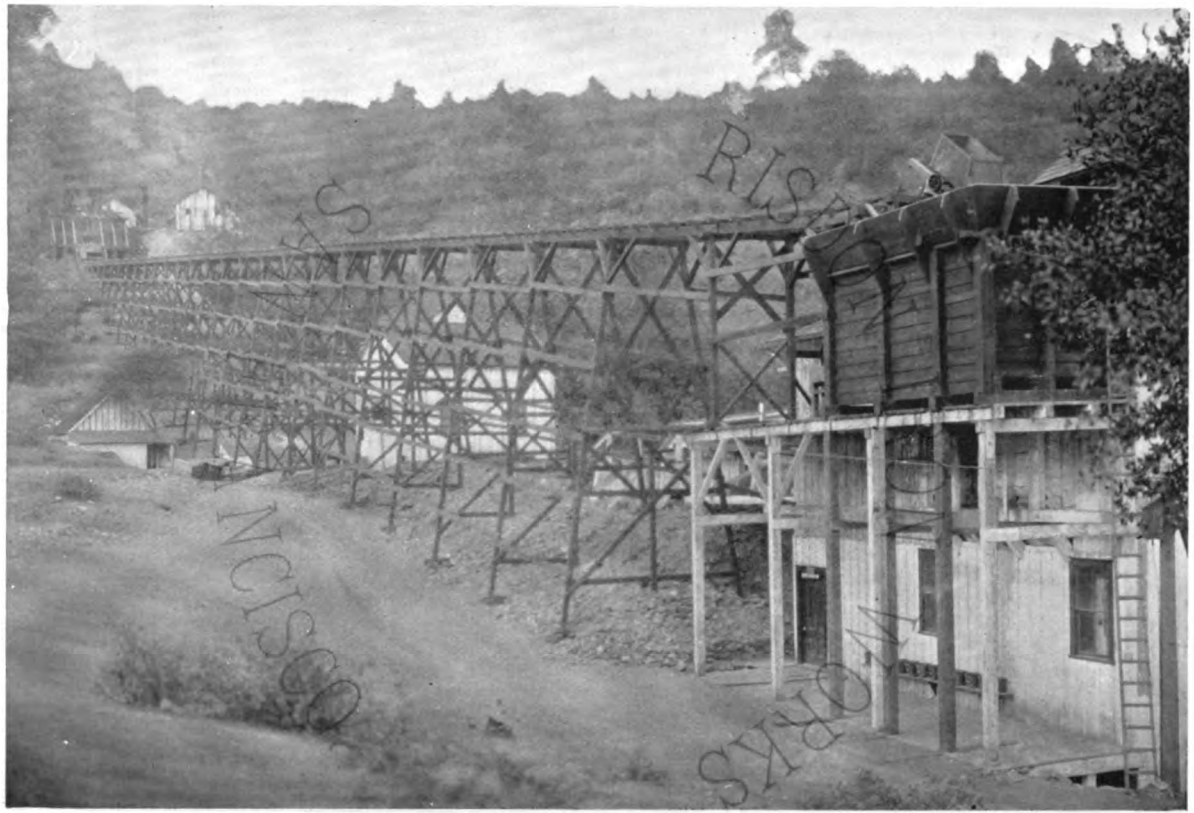


Incline Gravity Tramway.

RISDON IRON WORKS
SAN FRANCISCO

THE
JOHN CRERAR
LIBRARY.

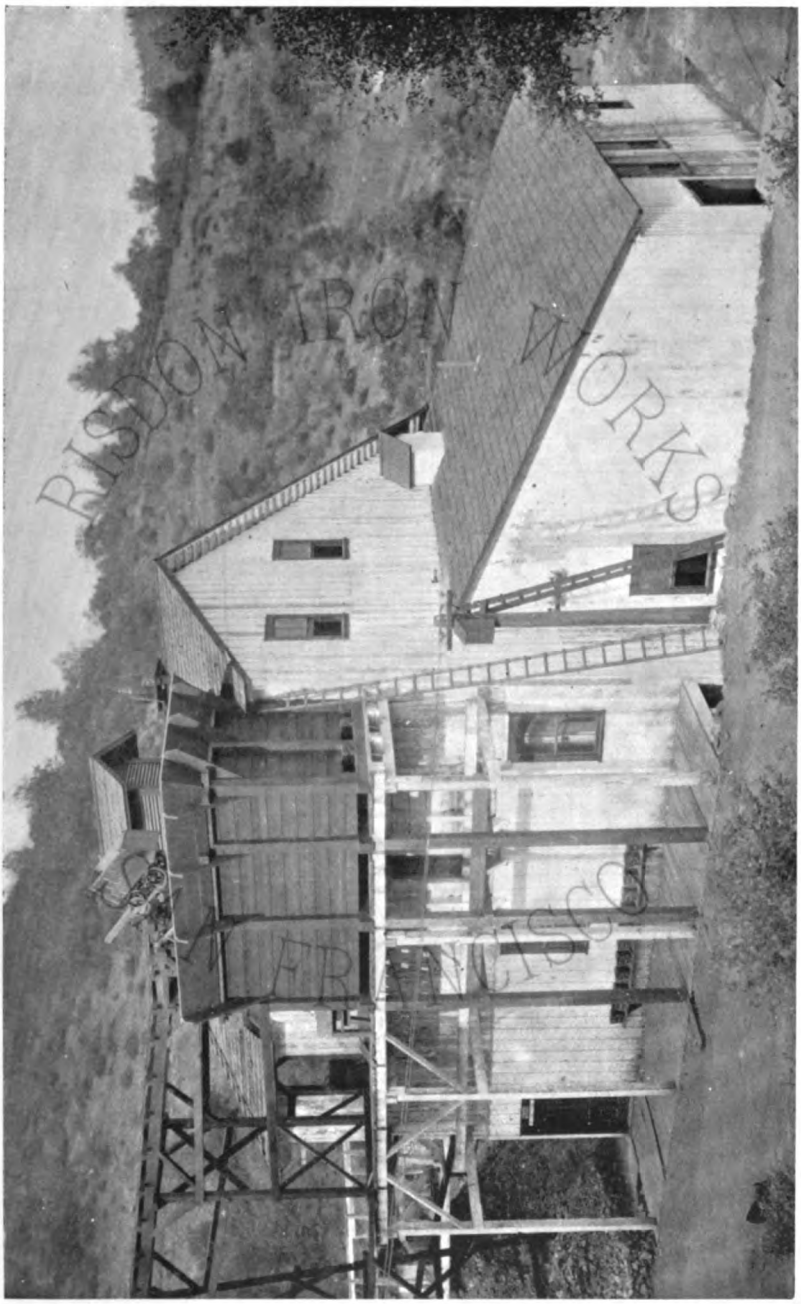
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GRAVITY TRAMWAY (Banner Pattern)

500 feet long, transporting 200 tons in ten hours

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DUMPING ARRANGEMENT ON GRAVITY TRAMWAY

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STEADY STRAIN vs. SUDDEN JERK.

A Series of Tests Made by a Large Western Mining Company on a Hoisting Rope with a Short Chain Attached to One End. Showing Difference in Strain upon Wire Rope when Started Gently or with a Sudden Jerk, Carefully Ascertained with a Dynamometer.

FIRST TEST.

No. 1, Empty Cage lifted gently	3,600 lbs.
No. 2, " "	3,600 "
No. 1, with 2½ inch Slack Chain	4,100 "
No. 2, " 2½ " "	4,100 "
No. 1, " 6 " "	8,000 "
No. 2, " 6 " "	8,000 "
No. 1, " 12 " "	11,000 "
No. 2, " 12 " "	11,000 "

SECOND TEST.

Cage and four Empty Cars, weighed by machine	5,700 lbs.
No. 1, Cage lifted gently	6,000 "
No. 2, " "	6,000 "
No. 1, with 3 inch Slack Chain	10,000 "
No. 2, " 3 " "	10,000 "
No. 1, " 6 " "	11,000 "
No. 2, " 6 " "	11,000 "
No. 1, " 12 " "	14,000 "
No. 2, " 12 " "	14,000 "

THIRD TEST.

Cage and Full Cars, weighed by machine	10,100 lbs.
No. 1, lifted gently	10,100 "
No. 2, "	10,300 "
No. 1, with 3 inch Slack Chain	17,000 "
No. 2, " 3 " "	17,000 "
No. 1, " 6 " "	21,000 "
No. 2, " 6 " "	23,000 "
No. 1, " 9 " "	25,000 "
No. 2, " 9 " "	23,000 "

We give the above series of tests so that users of wire rope may see the serious effect of starting a load with wire rope in a careless manner, as it is of great interest to manufacturers of wire rope, as well as consumers to have the rope give the longest life possible.

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INCLINED PLANE.

For the benefit of those desiring to use wire rope on slopes, inclined planes, etc., we subjoin a table by which the strain produced by any load can easily be calculated.

The table gives the strain produced on a rope by a load of one ton of two thousand pounds, an allowance for rolling friction being made. An additional allowance for the weight of the rope will have to be made.

Example: For an inclination of 25 in 100 feet, corresponding to an angle of $14\frac{1}{12}$ degrees, a load of 2000 pounds will produce a strain on the rope of 497 pounds, and for a load of 8000 pounds the strain on the rope will be $\frac{497 \times 8000}{2000} =$ 1988 pounds.

Elevation in 100 Feet.	Corresponding Angle of Inclination from Horizontal in Degrees.	Strain in Pounds on Rope from a Load of 2000 lbs.	Elevation in 100 Feet.	Corresponding Angle of Inclination from Horizontal in Degrees.	Strain in Pounds on Rope from a Load of 2000 lbs.
5	$2\frac{7}{8}$	112	95	$43\frac{1}{2}$	1385
10	$5\frac{1}{2}$	211	100	45	1419
15	$8\frac{1}{3}$	308	105	$46\frac{1}{2}$	1457
20	$11\frac{1}{5}$	404	110	$47\frac{3}{4}$	1487
25	$14\frac{1}{12}$	497	115	49	1516
30	$16\frac{3}{4}$	586	120	$50\frac{1}{4}$	1544
35	$19\frac{1}{5}$	673	125	$51\frac{1}{2}$	1570
40	$21\frac{5}{6}$	754	130	$52\frac{1}{2}$	1592
45	$24\frac{1}{4}$	832	135	$53\frac{1}{2}$	1614
50	$26\frac{1}{3}$	905	140	$54\frac{1}{2}$	1633
55	$28\frac{5}{6}$	975	145	$55\frac{1}{2}$	1653
60	31	1040	150	$56\frac{1}{4}$	1671
65	$33\frac{1}{12}$	1100	155	$57\frac{1}{4}$	1689
70	35	1156	160	58	1703
75	37	1210	165	$58\frac{1}{3}$	1717
80	$38\frac{2}{3}$	1260	170	$59\frac{1}{2}$	1720
85	$40\frac{1}{2}$	1304	175	$60\frac{1}{4}$	1742
90	42	1347			

A factor of safety of five to seven times should be taken; that is, the working load on the rope should only be one-fifth to one-seventh of its breaking strength. As a rule, ropes for shafts should have a factor of safety of five, and on inclined planes where the wear is much greater, the factor of safety should be seven.

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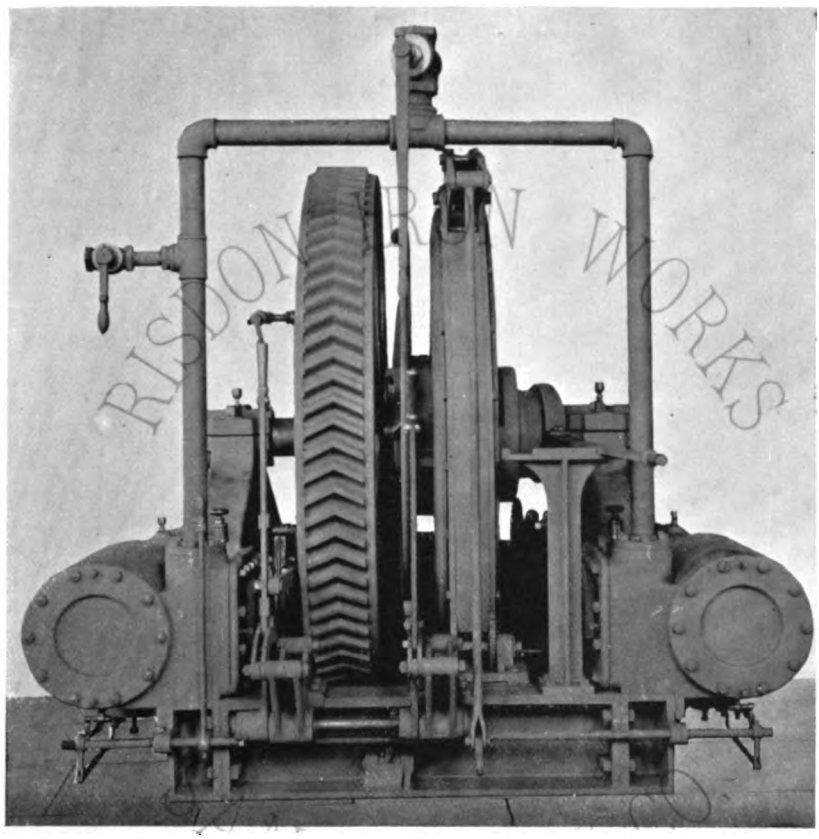
OVERHEAD SHEAVES

We build all kinds of Overhead Sheaves for flat and round rope. For the latter we use traversing shafts when large quantities of rope are used requiring wide drums. This will keep the rope better in line with coil on drum. The weight includes shaft boxes and bolts. We assume the shaft to be not over 2 feet long.

ROUND ROPE.				FLAT ROPE.				
						Rope.		
No.	Diam., Inches.	Diam. Rope, Inches.	Weight, Pounds.	No.	Diam., Inches.	Width, Inches.	Thickness Inches.	Weight, Pounds.
1	36	5/8	300	1	36	3	3/8	300
2	42	3/4	350	2	48	3 1/2	3/8	400
3	48	7/8	400	3	60	4	1/2	500
4	54	7/8	450	4	72	4 1/2	1/2	750
5	60	1	500	5	84	5	5/8	1,200
6	72	1	700	6	96	6	3/4	1,800

Other sizes made to order.

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Single Reel Double Cylinder Link Motion Underground Sinking Hoist.

Clutch on Drum Shaft, Post and Disc Brakes

For description see page 14

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Eight Strand Extra Flexible Plow Steel Rope

This term is applied to the finest grade of steel wire rope that can be produced in the present state of the art.

The wire is made from a high grade of Crucible Steel having a tensile strength of from 250,000 to 300,000 lbs. per square inch, and ropes made from this wire possess the greatest possible strength and wearing qualities.

It is made of 8 strands laid about a hemp center. Each of the strands is composed of 19 wires, the rope thus having 152 wires in all.

This rope is especially adapted for logging purposes.

In all hoisting service, especially in deep shafts or long inclines where the dead weight of the rope forms a large part of the load raised each time, or in remote localities where transportation is difficult and expensive, a rope combining a maximum of strength and wearing qualities with a minimum of weight, is not only desirable but the most economical.

In using Plow Steel Ropes avoid bends and use as large sheaves and drums as possible. As a rule it is not advisable to go below the sizes given in the table for *Crucible Steel Ropes of Equal Strength.* Thus a 1-inch Plow Steel Rope has about the same strength as a 1¼-inch Crucible Steel Rope, and could be used on the same sized drums.

In ordering Plow Steel Ropes, please give the fullest particulars as to manner of use, greatest load, size and construction of drums or sheaves, number of bends, etc., etc., that the wire may be so tempered as best suited to this particular service.

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Eight Strand Extra Flexible Plow Steel Rope

NINETEEN WIRES TO THE STRAND.

Trade No.	Diameter in Inches	Price per foot in cents	Weight per foot in pounds of Rope with Hemp Center	Breaking strain in tons of 2,000 pounds	Proper working load in tons of 2,000 pounds	Min. size of drum or sheave in feet
1	2 1/4	130	8.00	230	46	11
2	2	104	6.30	185	37	10
3	1 3/4	87	5.25	155	31	9
4	1 5/8	70	4.10	125	25	8
5	1 1/2	60	3.65	115	23	7
5 1/2	1 3/8	50	3.00	95	19	6
6	1 1/4	41	2.50	76	15	5 1/2
7	1 1/8	34	2.00	63	12	5
8	1	28	1.58	50	9	4 1/2
9	7/8	22	1.20	37	7	4
10	3/4	16 1/2	0.88	27	5	3 1/2
10 1/4	5/8	12 1/2	0.60	20	3 1/2	3
10 1/2	9/16	10 1/2	0.48	15	3	2 3/4
10 3/4	1/2	9	0.39	12	2 1/2	2 1/2
10a	7/16	8 1/2	0.29	10	2	2 1/4
10 7/8	3/8	8	0.23	8	1 1/2	2

SEVEN WIRES TO THE STRAND.

11	1 1/2	58	3.37	93	19	12
12	1 3/8	48	2.77	78	15	11
13	1 1/4	40	2.28	66	13	10
14	1 1/8	33	1.82	54	11	9
15	1	27	1.50	45	9	7
16	7/8	21	1.12	33	6 1/2	6
17	3/4	16	0.88	25	4 1/2	5
18	11/16	13	0.70	21	4	5
19	5/8	11	0.57	17	3 1/2	4 1/2
20	9/16	8 1/2	0.41	14	3	4
21	1/2	7	0.31	11	2	4
22	7/16	5	0.23	8	1 1/2	3 3/4
23	3/8	4 1/4	0.21	6	1 1/4	3 1/2
24	5/16	3 3/4	0.16	5	1	3 1/4
25	9/32	3	0.125	4	3/4	3

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CRUCIBLE CAST STEEL

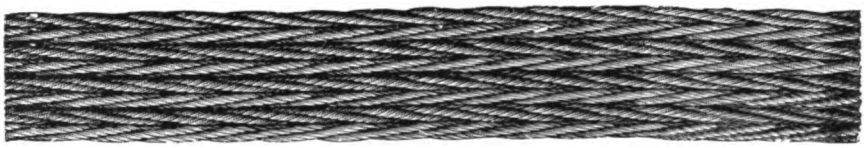
This wire is made from the best quality of Crucible Cast Steel, and the ropes are more than double the strength of similar ropes made of Iron Wire.

The use of Steel Ropes in place of Iron is daily becoming more general.

Trade No.	Diameter in inches	Price per foot in cents	Circumference in inches	Circumference of Hemp Rope of Equal Strength	Weight per foot in lbs. of Rope with Hemp Center	Breaking Strain in tons of 2000 pounds	Proper working load in tons of 2000 pounds	Minimum size of drum or sheave in feet
1	2¼	92	6¾		8.00	155	31	9
2	2	72	6		6.30	125	25	8
3	1¾	60	5½	15¾	5.25	106	21	7½
4	1⅝	48	5	14½	4.10	86	17	6
5	1½	43	4¾	13½	3.65	77	15	5½
5½	1⅜	36	4⅜	12¼	3.00	63	12	5¼
6	1¼	30	4	11½	2.50	52	10	5
7	1⅛	25	3½	10	2.00	42	8	4½
8	1	19	3⅛	9¼	1.58	33	6	4
9	⅞	15	2¾	8	1.20	25	5	3¾
10	¾	11½	2¼	6½	0.88	18	3	3½
10¼	⅝	9	2	5¼	0.60	14	2	3
10½	9/16	8	1⅝	4¾	0.48	9	1½	2¾
10¾	½	7	1½	4½	0.39	7½	1	2
10a	7/16	6½	1⅜	4	0.29	6	1	1¾
10⅞	⅜	6	1¼	3½	0.23	4½	¾	1½

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FLAT WIRE ROPES.



CRUCIBLE STEEL FLAT ROPES.

SIZE.	Approximate Weight per Foot.	Approximate Strength in Pounds.	SIZE.	Approximate Weight per Foot.	Approximate Strength in Pounds.
⅜ x 2	1.35	36,000	½ x 2½	1.93	67,000
⅜ x 2½	1.70	55,800	½ x 3	2.40	75,000
⅜ x 3	2.00	60,000	½ x 3½	2.97	89,000
⅜ x 3½	2.50	75,000	½ x 4	3.30	99,000
⅜ x 4	2.75	85,800	½ x 4½	4.00	115,000
⅜ x 4½	3.12	93,600	½ x 5	4.27	120,000
⅜ x 5	3.40	100,000	½ x 5½	4.82	144,000
⅜ x 5½	3.90	110,000	½ x 6	5.10	153,000
⅜ x 6	4.15	120,000	½ x 7	5.90	177,000
½ x 2	1.55	60,000	½ x 8	6.90	200,000

Steel Wire Flat Ropes are composed of a number of strands, alternately twisted to the right and left, laid alongside of each other and sewed together with soft Norway iron wires. These ropes are used at times in place of round ropes in the shafts of mines. They wind upon themselves on a narrow winding-drum, which takes up less room than one necessary for a round rope. The soft-iron sewing-wire wears out sooner than the steel strands, and then it becomes necessary to sew the rope with new iron wires.

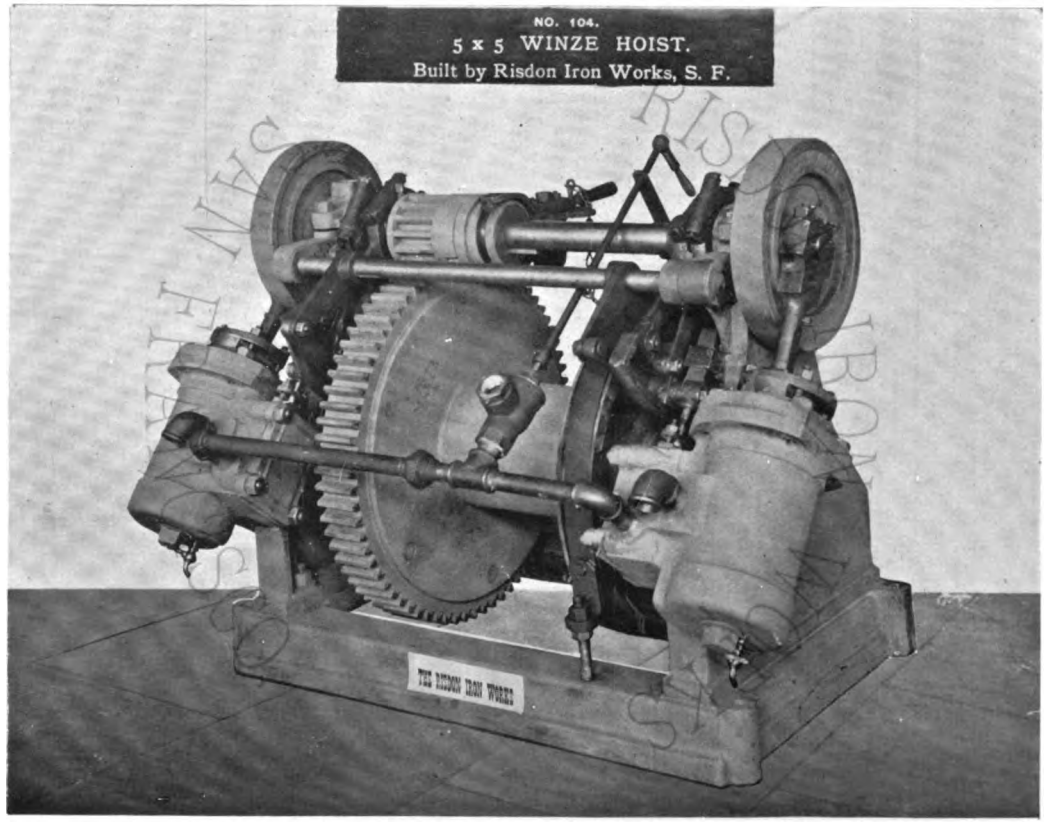
PLOW STEEL QUALITY.

We are prepared to furnish Flat Ropes of the celebrated Plow Steel Wires, having 275,000 pounds tensile strength per square inch, at slightly increased cost.

FLAT ROPE STRAND, of any quality desired, and SWEDISH IRON SEWING WIRE furnished when customers prefer to sew their Flat Ropes at the mine.

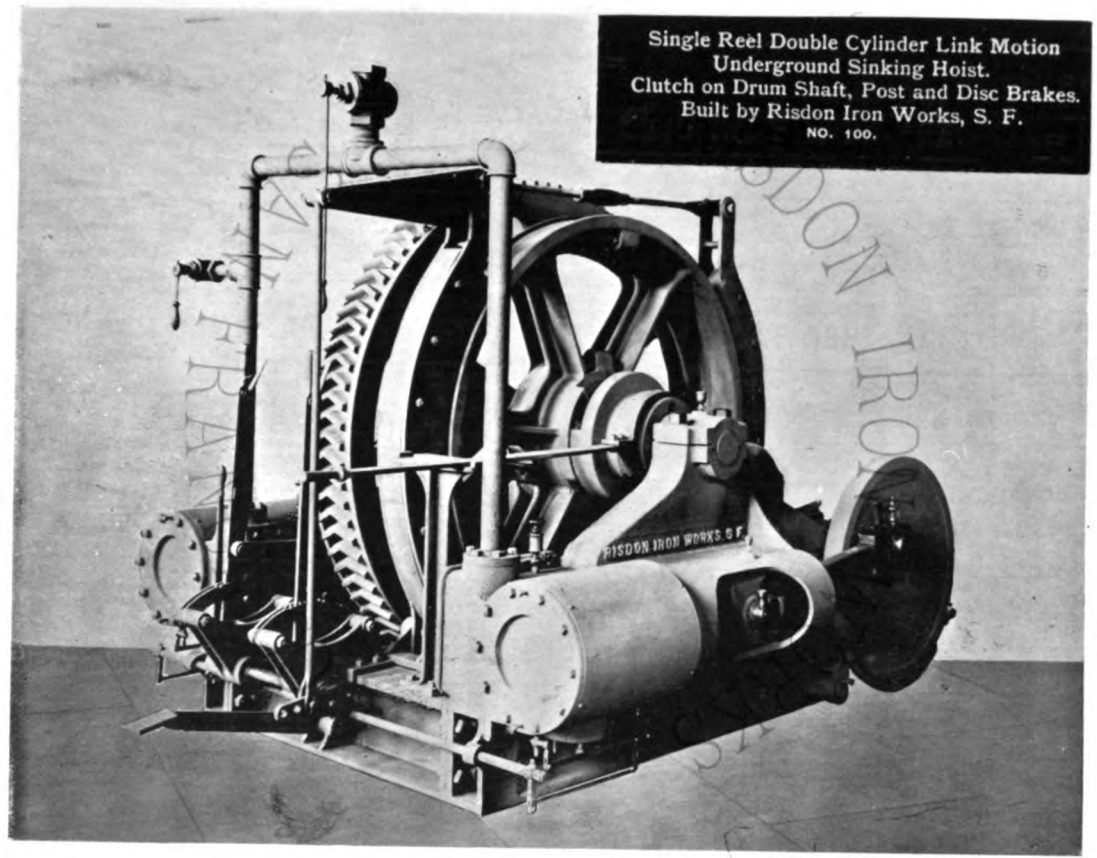
The Plow Steel Ropes are 50 per cent Stronger than above Table for Same Size.

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For description, see page 14.

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For description, see pages 18 to 21.

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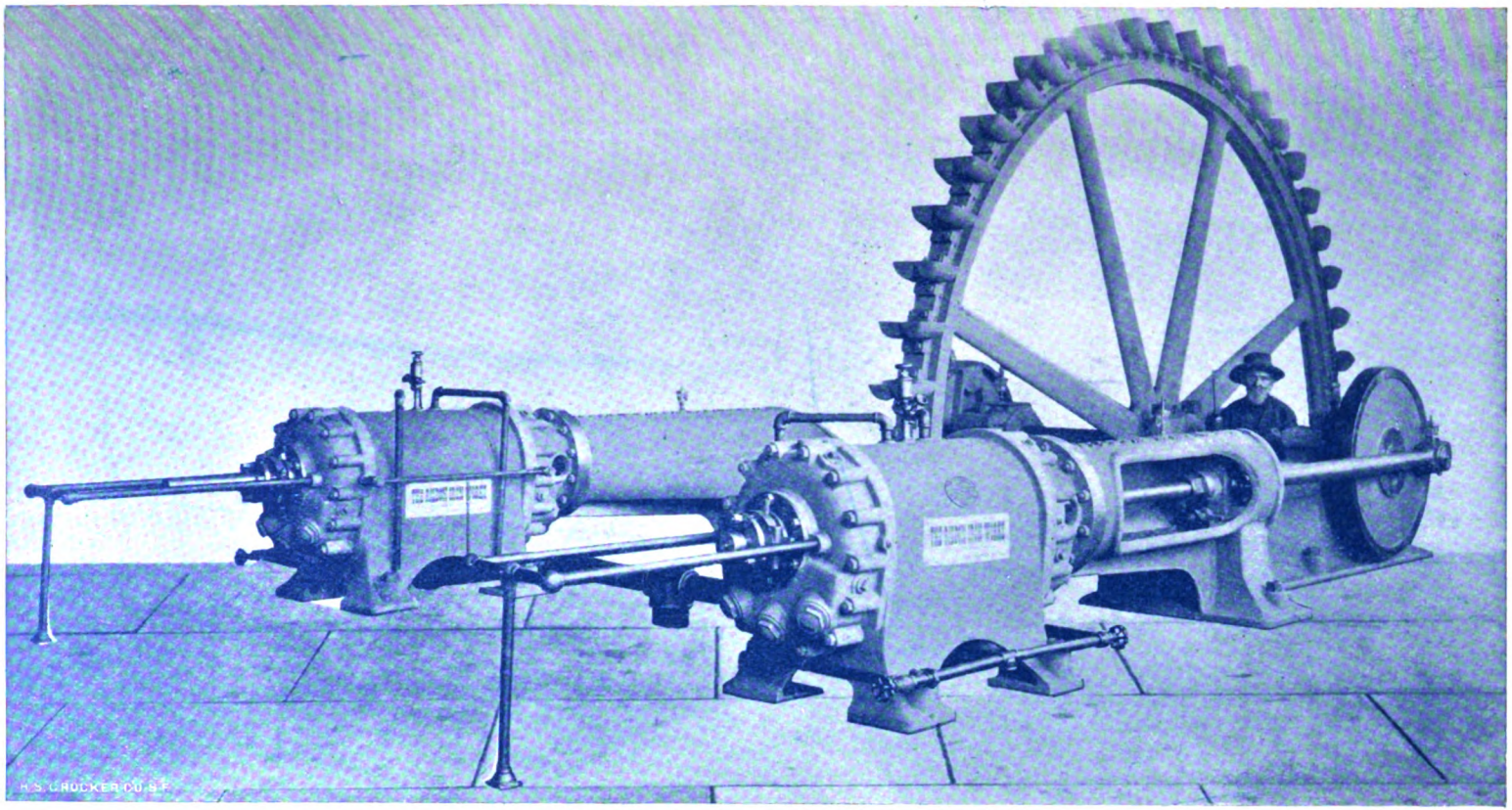
Diameters, Circumferences and Areas of Circles,

IN FEET,

And Contents in Gallons at One Foot in Depth.

Diameter.		Circum.		Area, in feet.	Gallons, 1 foot in depth.	Diameter		Circum.		Area, in feet.	Gallons, 1 foot in depth.	Diam eter.		Circum.		Area, in feet	Gallons, 1 foot in depth.
Feet.	Inches.	Feet.	Inches.			Feet.	Inches.	Feet	Inches			Feet.	Inches.	Feet.	Inches.		
1		3	1⅛	.78	5 87	6		18	10⅛	28.27	211.44	19		59	8¼	283.52	2120.34
1	1	3	4⅜	.92	6.89	6	3	19	7½	30.67	229.43	19	3	60	5⅜	291.03	2176.51
1	2	3	8	1.06	7 99	6	6	20	4⅞	33.18	248.15	19	6	61	3⅛	298.64	2233.29
1	3	3	11	1.22	9.17	6	9	21	2⅜	35.78	267 61	19	9	62	½	306.35	2291.04
1	4	4	2⅛	1.39	10.44												
1	5	4	5⅜	1.57	11 78	7		21	11⅞	38.48	287.80	20		62	9⅞	314.16	2349.41
1	6	4	8½	1.76	13.21	7	3	22	9¼	41 28	308 72	20	3	63	7⅛	322.06	2408.51
1	7	4	11⅝	1.96	14.72	7	6	23	6¾	44.17	330.38	20	6	64	4⅛	330.06	2468.35
1	8	5	2¾	2 18	16 31	7	9	24	4⅛	47.17	352 76	20	9	65	2¼	338.16	2528 92
1	9	5	5⅞	2.40	17 98												
1	10	5	9	2.63	19 74	8		25	1½	50.26	375 90	21		65	11⅜	346.36	2590.22
1	11	6		2.88	21.48	8	3	25	11	53.45	399.76	21	3	66	9	354.65	2652 25
						8	6	26	8⅜	56.74	424 36	21	6	67	6½	363.05	2715.01
2		6	3⅛	3.14	23.49	8	9	27	5¾	60.13	449.21	21	9	68	3⅞	371.54	2778.54
2	1	6	6¼	3.40	25 49												
2	2	6	9⅜	3.68	27.57	9		28	3¼	63.61	475.75	22		69	1⅜	380.13	2842 79
2	3	7	¼	3.97	29.73	9	3	29	⅝	67.20	502 55	22	3	69	10¾	388.82	2907.76
2	4	7	3⅜	4.27	32.69	9	6	29	10⅛	70.88	530.08	22	6	70	8¼	397.60	2973 48
2	5	7	7	4 58	34.30	9	9	30	7½	74.66	558.35	22	9	71	5⅞	406.49	3039.92
2	6	7	10¼	4.90	36.70												
2	7	8	1⅜	5.24	39.19	10		31	5	78 54	587.35	23		72	3	415.47	3107.10
2	8	8	4½	5.58	41 76	10	3	32	2⅜	82.51	617.08	23	3	73	½	424.55	3175 01
2	9	8	7⅝	5 93	44.41	10	6	32	11¼	86.59	647.55	23	6	73	9⅞	433.73	3243.65
2	10	8	10¾	6.30	47.15	10	9	33	9¼	90.76	678.27	23	9	74	7¼	443.01	3313.04
2	11	9	1⅜	6 68	49.96												
						11		34	6⅝	95.03	710.69	24		75	4¼	452 39	3383.15
3		9	5	7.06	52.86	11	3	35	4⅛	99 40	743.36	24	3	76	2⅛	461.86	3454.00
3	1	9	8¼	7.46	55.83	11	6	36	1½	103 86	776 77	24	6	76	11⅝	471.43	3525.50
3	2	9	11⅜	7.87	58.89	11	9	36	10⅞	108.43	810 91	24	9	77	9	481.10	3597 90
3	3	10	2½	8.29	62.03												
3	4	10	5⅝	8.72	65.26	12		37	8⅜	113.09	848.18	25		78	6⅛	490.87	3670.95
3	5	10	8¾	9 16	68 51	12	3	38	5¼	117.85	881 39	25	3	79	3⅞	500.74	3744 74
3	6	10	11⅞	9.62	73.15	12	6	39	3¼	122.71	917 73	25	6	80	10¼	510.70	3819.26
3	7	11	3	10.08	75 41	12	9	40	⅝	127.67	954.81	25	9	80	10¾	520.76	3894.52
3	8	11	6⅛	10.55	78.96												
3	9	11	9⅜	11.04	82.59	13		40	10	132.73	992 62	26		81	8⅛	530.93	3970.50
3	10	12	½	11.54	86.30	13	3	41	⅜	137 88	1031 17	26	3	82	5¼	541 18	4047.23
3	11	12	3⅜	12.04	90.10	13	6	42	⅞	143.13	1070 45	26	6	83	3	551.54	4124 68
						13	9	43	2¼	148 48	1108.06	26	9	84	⅜	562.00	4202.96
4		12	6¼	12.56	93 97												
4	1	12	9⅞	13 09	97 93	14		43	11¾	153 93	1151.21	27		84	9⅞	572.55	4281.80
4	2	13	1	13 63	101.97	14	3	44	9⅛	159.48	1192.69	27	3	85	7⅛	583.20	4361.46
4	3	13	4⅛	14 18	103.03	14	6	45	6⅝	165 13	1234 91	27	6	86	4⅜	593.95	4441.86
4	4	13	7¼	14.74	110 29	14	9	46	4	170 87	1277.86	27	9	87	2⅛	604.80	4522.98
4	5	13	10½	15.32	114.57												
4	6	14	1⅝	15.90	118.93	15		47	1½	176.71	1321.54	28		87	11½	615.75	4604 85
4	7	14	4⅜	16 49	123.38	15	3	47	10⅞	182.65	1365 96	28	3	88	9	626.79	4686.48
4	8	14	7⅜	17.10	127 91	15	6	48	8¼	188.69	1407 51	28	6	89	6¾	637.94	4770.77
4	9	14	11	17.72	132 52	15	9	49	5¾	194 82	1457.00	28	9	90	3¾	649 18	4854.84
4	10	15	2⅛	18.34	137.21												
4	11	15	5¼	18.98	142.05	16		50	3⅛	201.06	1503 62	29		91	1¼	660.52	4939.64
						16	3	51	½	207.39	1550.97	29	3	91	10⅜	671.95	5025.17
5		15	8½	19.63	146.83	16	6	51	10	213.82	1599.06	29	6	92	8⅛	683.49	5111.44
5	1	15	11⅜	20.29	151.77	16	9	52	7⅜	220 35	1647.89	29	9	93	5½	695.12	5198.44
5	2	16	2¼	20.96	156.78												
5	3	16	5¾	21 64	161.88	17		53	4⅞	226.98	1697.45	30		94	2¾	706.86	5286 18
5	4	16	9	22.34	167.06	17	3	54	2⅛	233.70	1747.74	30	3	95	⅜	718.69	5374.65
5	5	17	⅛	23.04	172.33	17	6	54	11⅜	240.52	1798 76	30	6	95	9¾	730.61	5463.85
5	6	17	3¼	23 75	177 67	17	9	55	9⅛	247.45	1850.53	30	9	96	7¼	742.64	5553.79
5	7	17	6⅜	24.48	183 09												
5	8	17	9⅝	25.21	188 60	18		56	6½	254.46	1903.02						
5	9	18	⅛	25.96	194.19	18	3	57	4	261.58	1956.25						
5	10	18	3⅞	26 72	199.86	18	6	58	1¾	268.80	2010.21						
5	11	18	7⅛	27 49	205.61	18	9	58	10¾	276.11	2064 91						

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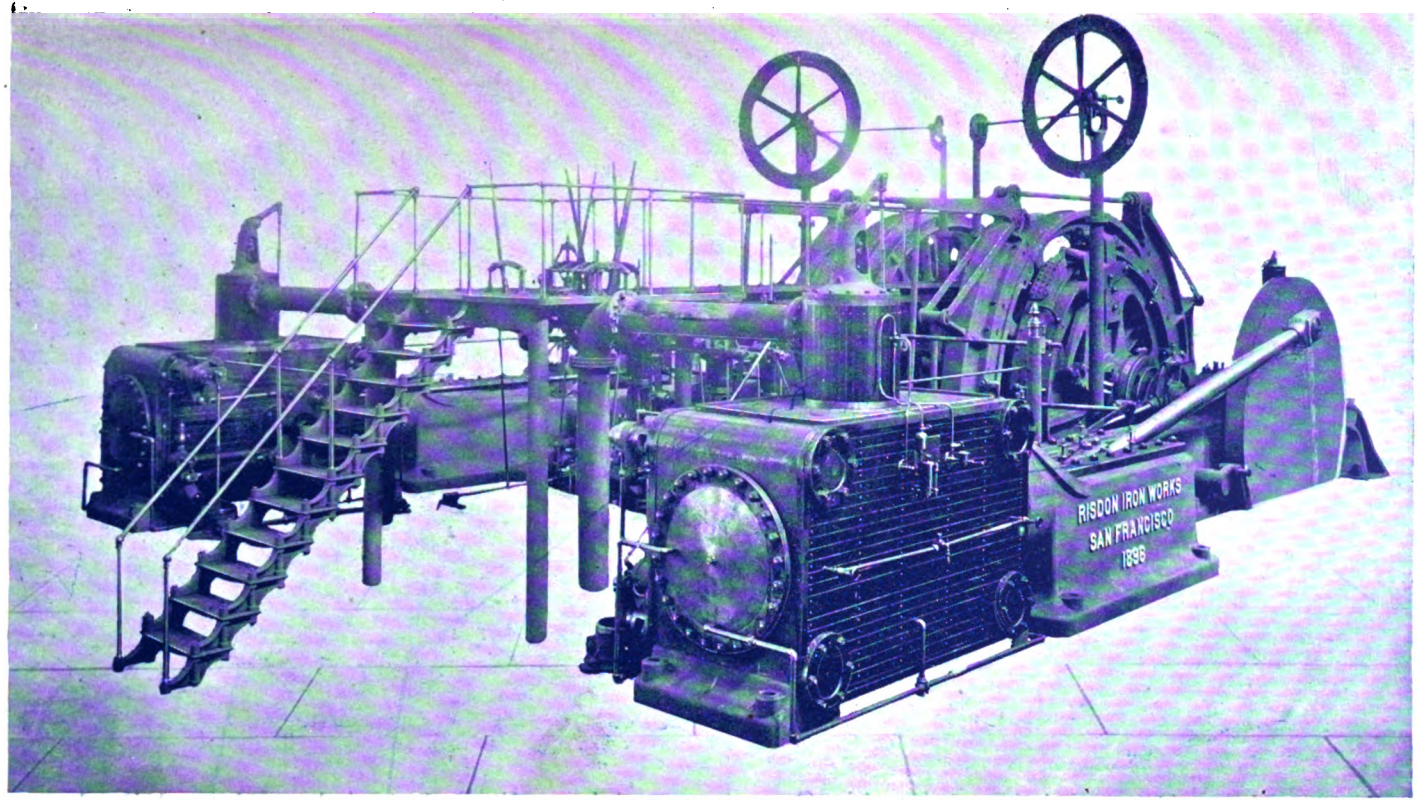


500 Horse Power Risdon Inlet Air Compressor, driven direct by Risdon Water Wheel, 24 feet diameter.

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3000 HORSE POWER HOISTING ENGINE



Direct Acting Hoisting Engine, to start load 40,000 lbs. and hoist same at an average speed of 3000 feet per minute. Capacity, 3500 feet Rope.

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CATALOGUE No. 4

Risdon Patent Tangential Water Wheels

PUBLISHED BY

The Risdon Iron Works

SAN FRANCISCO

CALIFORNIA

1898

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Terms, Shipments, Etc.

TERMS

Unless otherwise specified and previously agreed to, and to those customers who have not established credit relations with us, our terms are always one-third cash with the order and the balance when goods are ready to ship.

SHIPMENTS

Give full shipping directions with order. State whether preference is to be given to a certain route, and, if so, give the name of railroad, etc.

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The Risdon Patent Water Wheel.

This Wheel is one of that class known as Tangential water wheels.

Its high efficiency is due to the peculiar and distinctive form of its bucket, which is of such a nature that the water enters without shock and leaves without velocity.

In its construction and arrangement, it presents a feature not seen in any other wheel bucket of its class. The water never reacts from one bucket in such a manner as to strike a succeeding bucket. At no part of the passage of the bucket through the line of the stream is there presented any reacting surface which would have a tendency to deflect the water in any other than a clear and free direction, a very decided advantage over all other wheels yet made.

This wheel does not depend upon its diameter for the amount of power to be had from it; although the tables of power, etc., would seem to show this to be so. We have adopted a standard of certain sizes, for convenience only, and the tables indicate the power water supply, etc., that apply to these standards. That a larger wheel will call for more water and develop more power than a small one, is simply because the buckets of the large wheel are proportioned for a larger stream of water.

Different buckets may be adapted to suit almost any size or diameter of wheel, and thus the proportion of revolutions to power may be made to suit every condition of service to which these wheels are at all applicable

The tables are made up upon a basis of the use of one nozzle of the proper size to each wheel. The application of two or more nozzles to the wheels does not increase the revolutions; it only permits the use of more water, and consequently more power.

The use of two or more nozzles is often advisable, especially where wheels are to be used for hoisting rigs, or where, for any reason, a variation of power is desired without a change of speed.

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Information Correspondents Should Give in Writing for Water Wheels.

1. Head of water, measured from ditch or water source to point of application, in vertical feet.

2. Amount of water in miners' inches, or in cubic feet, or gallons per minute.

3. Power desired, or if unknown, describe the machinery to be run.

4. Distance of ditch or water source from water wheel, measured along the ground, for length of pipe.

5. If for pumping purposes, how much water is to be pumped and how high.

6. If you have counter shafts, or other shafts, to belt to, give speeds of same.

7. State whether you want Reversible Wheels, Hydraulic Gates, Governors, or Safety Valves in connection with your work.

8. State whether water is clear or muddy.

9. If for hoisting, give load and speed per minute.

SHOW IRON WORKS SAN FRANCISCO.

We make wheels to suit any special conditions of application, and all conditions of power, speed, water supply, etc., within the range of wheels of this class.

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Directions for Setting the Wheel.

Where we do not furnish the woodwork, we supply a complete detailed drawing of the frame and setting, so that any millwright may be able to make the necessary parts.

Make the frame and housing as shown in the drawing, and arrange to anchor it securely to a foundation. Remember that it is to be used instead of a large engine, perhaps, and it cannot be expected to stand still unless it is well bolted down.

The frame should be set fairly level, and when in place, cut in the recesses for the bearings, and leave a clearance at each end of same for adjustment and alignment. Set the shaft in place, and be sure the bearings are fair before bolting them down hard. End wedges of wood may then be put in.

On the regular sizes of wheels, we ship in one case the wheel center and buckets in place, all bolted securely. This saves the purchaser the trouble of putting on the buckets and perhaps overstraining the bolts.

The Nozzle.

A sheet iron templet, with directions for its use, is sent with every wheel, so that the nozzle may be properly set.

It is the water, not the wheel, that gives the power, and if the water is not properly directed, its power will not be obtained. The curved edges of the templet should be placed against the outer circle of the buckets, so that it may rest on three or four, and about in line with the center of the buckets.

Then bring the nozzle into such a position that it will fit the other side of the templet. This will then be the correct direction of the stream. It must also be set in such a way that the stream of water will be split in equal portions by the dividing wedge in the middle of the buckets.

This is important. The results obtained will be in proportion to the care used in setting the nozzle.

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Nozzle Tips.

With each wheel are sent three nozzle tips. It is advised to put in the smallest tip first, and then if not enough power is had, use a larger one. THE GATE is to be firmly secured to its place by the yoke bolts or other arrangement, as shown, and should be placed in the most convenient position for operation.

The Gate and nozzle must be firmly secured to the proper places, and all connections properly made before the water is turned into the pipe.

See that the pipe line is properly anchored, for it is not wise to depend too much on the frame and its foundation.

Speed of Wheels.

The proper speed of wheels is, in all cases, as set down in the tables under the different heads. The heads given are not to be considered as the *surveyed* head, but as the effective or hydrostatic head, after all losses by friction, etc., are deducted. For example: If the surveyed head is 250 feet, and it is found that the pressure by a gauge placed near the gate is but 95 pounds, when the proper nozzle tip is used, and the gate wide open, it will be seen that there is a friction loss of 30 feet. The wheel must then be arranged to have a speed as given under 220 feet, not 250 feet head.

Worth Noting.

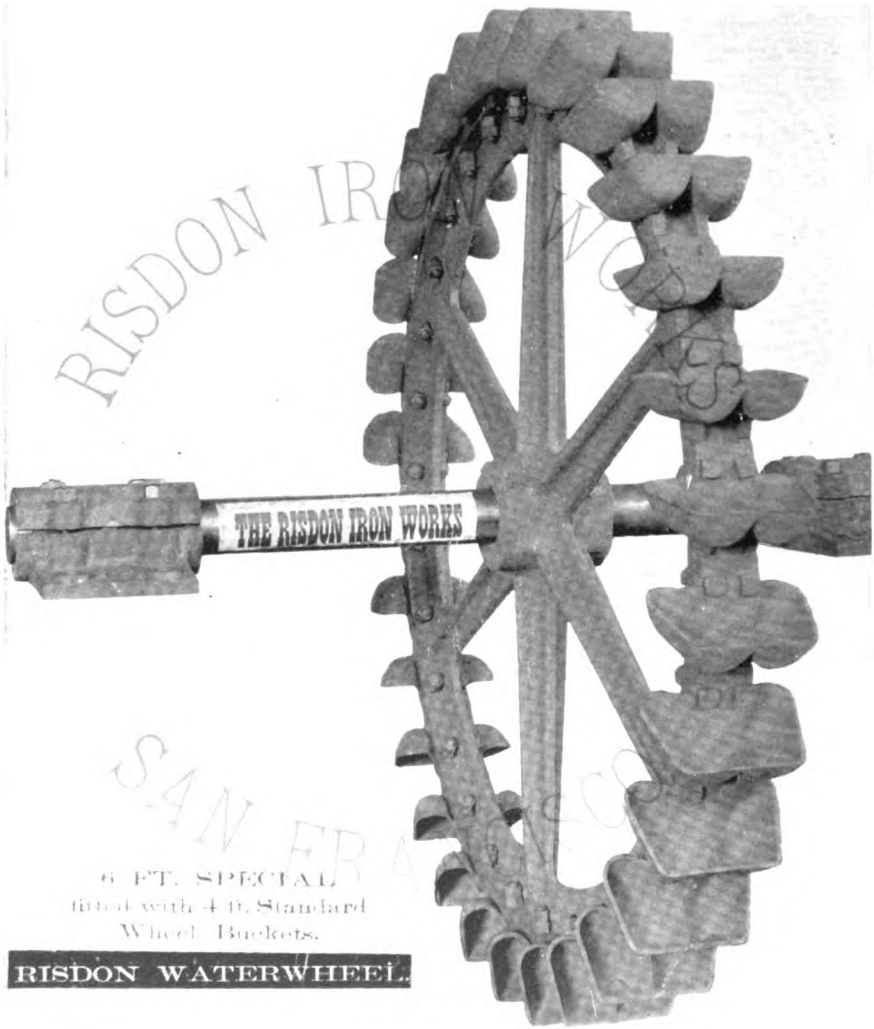
After running, from time to time, get out the NOZZLE TEMPLET, and by setting it to place, ascertain if the nozzle has shifted, and note that the stream is still being divided equally by the central wedge in the bucket. If any change has taken place, rectify it at once. The trouble will pay for itself many times over.

It will be found convenient to place a gauge, an ordinary steam gauge will do, connected by a pipe near the gate of the wheel. This will show the standing pressure of water when the wheel is not running, and indicate the friction head when the gate is open and the wheel running.

The proper size of nozzle tip is the one that will give the exact power required when the gate is wide open.

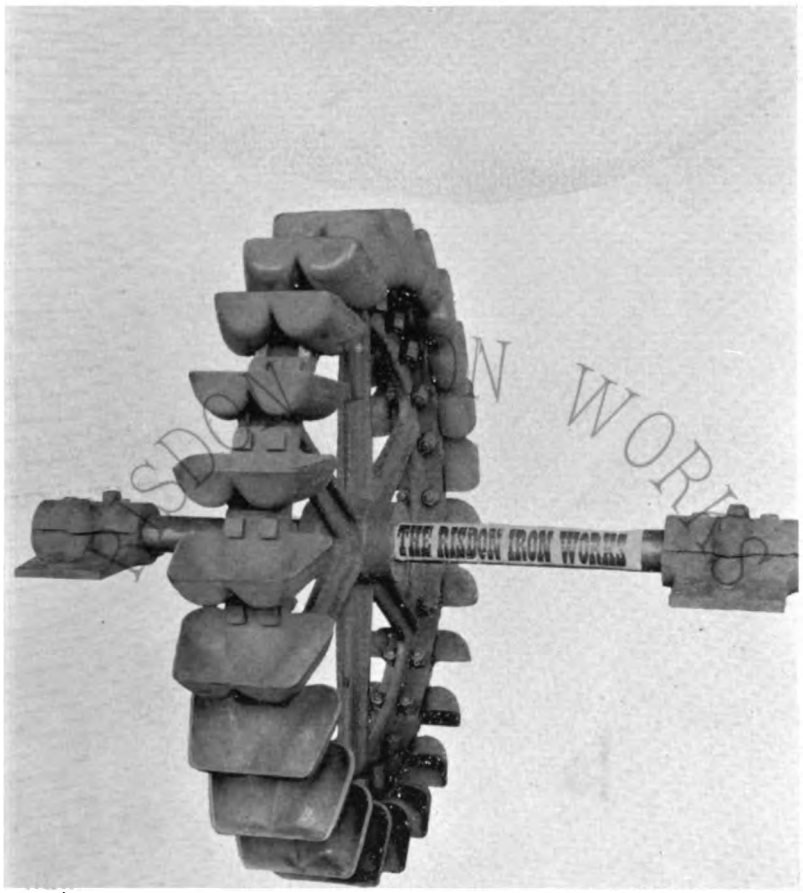
Provision must be made for the water to have a fair discharge after being used, so that it may not "back up" and fill the wheel pit.

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This wheel developes 300-horse power running 280 revolutions per minute, under a hydrostatic head of 500 feet.

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We illustrate on these pages the general construction of the RISDON PATENT WATER WHEEL. It will be noted that the buckets are bolted to the rim or center by heavy square-headed bolts with lock nuts, and each bucket butts closely with dove-tail to the one on each side of it, thereby giving a continuous ring when all are set in place. The buckets are all made inter-changeable, therefore do not require any numbering; and a customer, when receiving them will have no difficulty in placing them in proper position.

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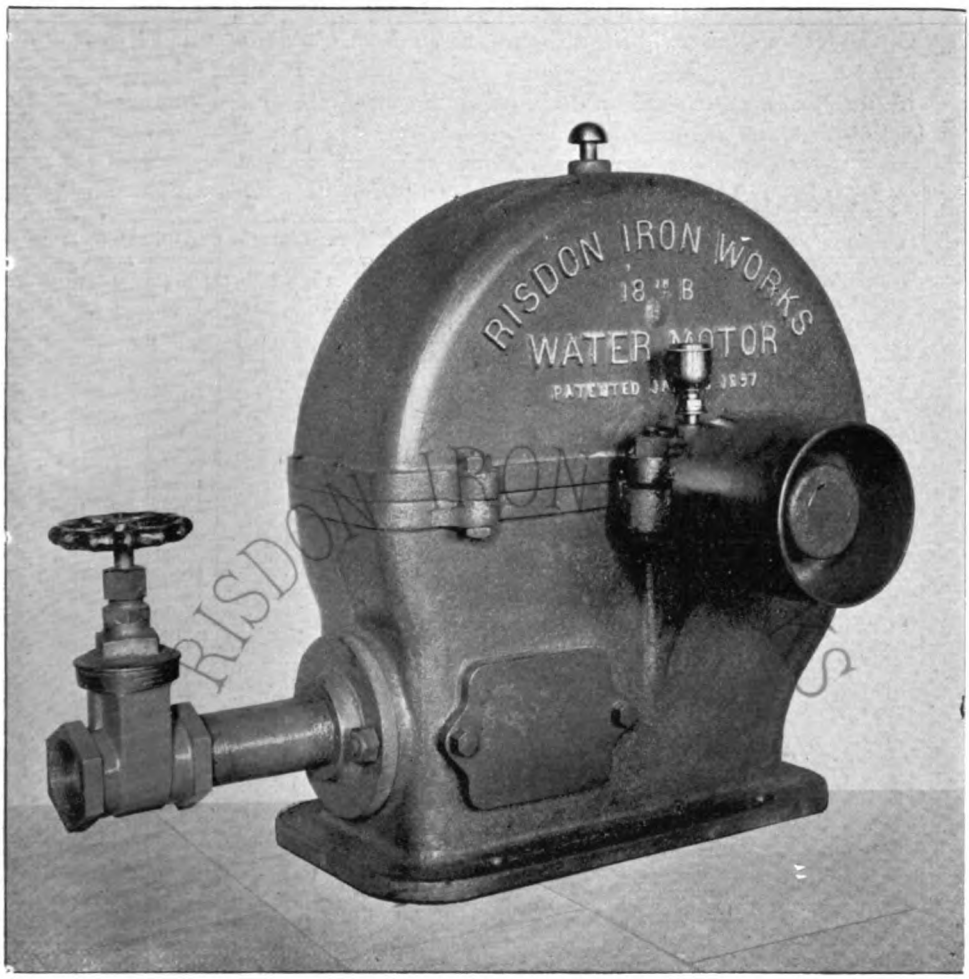
The Risdon Water Motor.



We make small water wheels, and for convenience of operation, enclose them in iron cases of a neat and mechanical design. Being thus complete within themselves, and self-contained, they are all ready to set in place, connect with the supply pipe and start up. We make these Motors in standard sizes, for convenience, and the tables of power, revolutions, etc., for the Motors show the maximum power and water consumption of each Motor under the given head. The powers of any of the Motors may be reduced to one quarter of the stated power without reducing the efficiency materially, by simply putting in a nozzle tip to vent only the necessary amount of water.

This Motor is guaranteed to perform its duty more efficiently and with more satisfaction than any Motor made.

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The standard sizes of our motors are as follows:

DIA. OF WHEEL.		WEIGHT.	PULLEY.	PRICE.
6 inches		30 pounds	3 inches	$ 30 00
12 "		95 "	4 x 4 "	60 00
18 "	A	250 "	5 x 5 "	125 00
18 "	B	275 "	6 x 6 "	175 00
24 "		600 "	10 x 8 "	275 00

The Standard Motors, as above list, are for what may be considered ordinary service. Under high heads, or for any special service, such as makes a wheel of proper size to give a certain number of revolutions under a given head, we make special wheels, and special prices.

The price includes the Motor, with the pulley, stop valve and three nozzle tips to give change of power.

For speeds, see notes on speed of wheels.

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Risdon Water Motor Tables

Giving Horse Power, Miner's Inches, Cubic Feet per Minute and Revolutions per Minute,

In these tables, the heads are to be taken as effective. No allowance is made for friction of water in pipes.

Head in Feet.		SIZE OF WHEELS.				
		6 in.	12 in.	18 in.	18 in.	24 in.
20	Horse Power..	.05	.12	.20	.37	.66
	Cubic Feet....	1.67	3.91	6.62	11.72	20.83
	Miner's Inches.	1.04	2.44	4.00	7.82	13.88
	Revolutions...	684	342	228	228	171
30	Horse Power..	.10	.23	.38	.69	1.22
	Cubic Feet....	2.05	4.79	8.11	14.36	25.51
	Miner's Inches	1.28	2.99	5.06	9.57	17.00
	Revolutions ..	837	418	279	279	209
40	Horse Power..	.15	.35	.59	1.06	1.89
	Cubic Feet....	2.87	5.53	9.37	16.59	29.46
	Miner's Inches	1.48	3.45	5.85	11.06	19.64
	Revolutions...	969	484	323	323	242
50	Horse Power..	.21	.49	.84	1.49	2.65
	Cubic Feet....	2.64	6.18	10.47	18.54	32.93
	Miner's Inches	1.65	3.86	6.54	12.36	21.95
	Revolutions...	1083	5 41	361	361	270
60	Horse Power..	.28	.65	1.10	1.96	3.48
	Cubic Feet....	2.90	6.77	11.47	20.31	36.08
	Miner's Inches	1.81	4.23	7.16	13.54	24.05
	Revolutions...	1185	592	395	395	296
70	Horse Power..	.35	.82	1.39	2.47	4.39
	Cubic Feet....	3.13	7.31	12.39	21.94	38.97
	Miner's Inches.	1.95	4.56	7.74	14.63	25.98
	Revolutions...	1281	640	427	427	320
80	Horse Power..	.43	1.00	1.70	3.01	5.36
	Cubic Feet....	3 35	7.82	13.25	23.46	41.66
	Miner's Inches.	2.09	4.88	8.28	15.64	27 77
	Revolutions...	1368	684	456	456	342
90	Horse Power..	.51	1.20	2.03	3.60	6 39
	Cubic Feet...	3.55	8.29	14.05	24.88	44.19
	Miner's Inches.	2 22	5.18	8.78	16.58	29.46
	Revolutions...	1452	726	484	484	363
100	Horse Power..	.60	1.40	2.32	4.21	7.49
	Cubic Feet....	3.74	8.74	14.81	26.22	46.58
	Miner's Inches.	2.33	5.46	9.25	17.48	31.05
	Revolutions...	1539	765	510	510	382
110	Horse Power..	.69	1.62	2.74	4 86	8.64
	Cubic Feet....	3.92	9.16	15.53	27.50	48.85
	Miner's Inches.	2.45	5.72	9.70	18.33	32.56
	Revolutions...	1605	802	535	535	401
120	Horse Power..	.79	1 84	3.12	5 54	9 85
	Cubic Feet....	4.10	9.57	16.21	28.72	51.02
	Miner's Inches.	2.56	5.98	10.13	19.15	34.01
	Revolutions ..	1677	838	559	559	419
130	Horse Power.	.89	2.08	3.53	6.25	11.11
	Cubic Feet....	4.27	9.96	16.89	29 90	53.10
	Miner's Inches.	2.66	6.22	10.55	19.93	35.40
	Revolutions...	1746	873	582	582	436
140	Horse Power..	.99	2.33	3.94	6.99	12.41
	Cubic Feet....	4.43	10.34	17.53	31.03	55.11
	Miner's Inches.	2.76	6.46	10.95	20.68	36.74
	Revolutions...	1812	906	604	604	453
150	Horse Power..	1.10	2.58	4.37	7.75	13.77
	Cubic Feet...	4.55	10.70	18.14	32.11	57.04
	Miner's Inches.	2.84	6.68	11.33	21.41	38.03
	Revolutions...	1875	937	625	625	468
160	Horse Power .	1.22	2.84	4.82	8.54	15.17
	Cubic Feet....	4.73	11.05	18.74	33.17	58.92
	Miner's Inches.	2.95	6.90	11.71	22.11	39.28
	Revolutions ..	1938	969	646	646	484

Head in Feet.		SIZE OF WHEELS.				
		6 in.	12 in.	18 in.	18 in.	24 in.
170		1.33	3.11	5.28	9.35	16.61
		4.88	11.39	19.31	34.19	60.73
		3.05	7.11	12.06	22.79	40.48
		1995	997	665	665	498
180		1.45	3.39	5.75	10.19	18.10
		5.02	11.72	19.87	35.18	62.49
		3.13	7.32	12.41	23.45	41.66
		2049	1024	683	683	513
190		1.57	3.68	6.24	11.05	9.63
		5.16	12.04	20.41	36.14	64.20
		3.22	7.52	12.75	24.09	42.80
		2106	1053	702	702	527
200		1.70	3.97	6.74	11.93	21.20
		5.29	12.36	20.94	37.08	65.87
		3.36	7.72	13.08	24.72	43.91
		2160	1080	720	720	540
210		1.83	4.28	7.25	12.84	22.81
		5.42	12.66	21.45	38.00	67.50
		3.38	7.91	13.41	25.33	45.00
		2214	1107	738	738	553
220		1.96	4.59	7.77	13.77	24.46
		5.55	12.96	21.96	38.89	69.08
		3.46	8.10	13.72	25.93	46.05
		2268	1134	756	756	567
230		2.10	4.90	8.31	14.72	26.15
		5.68	13.25	22.46	39.77	70.64
		3.55	8.28	14.03	26.51	47.09
		2319	1159	773	773	580
240		2.24	5.23	8.86	15.69	27.87
		5.80	13.54	22.93	40.62	72.16
		3.62	8.46	14.33	27.08	48.10
		2370	1185	790	790	592
250		2.38	5.56	9.42	16.68	29.63
		5.92	13.82	23.42	41.46	73.64
		3.70	8.63	14.63	27.64	49.09
		2418	1209	806	806	605
260		2.52	5.89	10.05	17.69	31.43
		6.04	14.09	23.88	42.28	75.10
		3.77	8.80	14.92	28.19	50.07
		2466	1233	822	822	617
270		2.67	6.24	10.67	18.72	33.26
		6.15	14.36	24.34	43.09	76.53
		3.84	8.97	15.21	28.72	51.02
		2514	1257	838	838	628
280		2.82	6.59	11.16	19.77	35.12
		6.26	14.62	24.79	43.88	77.94
		3.91	9.13	15.49	29.25	51 29
		2562	1281	854	854	639
290		2.97	6.94	11.77	20.84	37.02
		6.38	14.88	25.23	44.66	79.32
		3.98	9.30	15.76	29.77	52.88
		2607	1303	869	869	651
300		3.13	7.31	12.38	21.93	38.95
		6.48	15.13	25.66	45.42	80.67
		4.05	9.45	16.03	30.28	53.78
		2652	1326	884	884	663
310		3.29	7.68	13.01	23.04	40.92
		6.59	15.39	26.08	46.17	82.01
		4.11	9.61	16.30	30.78	54.67
		2697	1348	899	899	674

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Risdon Water Motor Tables

Giving Horse Power, Miner's Inches, Cubic Feet per Minute and Revolutions per Minute.

In these tables, the heads are to be taken as effective. No allowance is made for friction of water in pipes.

Head in Feet.		SIZE OF WHEELS. 6 in.	12 in.	18 in.	18 in.	24 in.	Head in Feet.	SIZE OF WHEELS. 6 in.	12 in.	18 in.	18 in.	24 in.
320	Horse Power..	3.45	8.05	13.64	24.16	42.91	470	6.14	14.33	24.29	43.01	76.40
	Cubic Feet.. .	6.70	15.63	26.50	46.91	83.32		8.12	18.95	32.11	56.85	100.98
	Miner's Inches.	4.18	9.76	16 56	31.27	55.55		5.07	11.84	20.06	37.90	67.32
	Revolutions...	2739	13.69	913	913	685		3321	1660	1107	1107	830
330	Horse Power .	3.61	8.43	14.29	25.30	44.94	480	6.34	14.79	25.07	44.39	78.85
	Cubic Feet....	6.80	15.88	26.91	47.64	84.61		8.20	19.15	32 45	57.45	102.05
	Miner's Inches	4.25	9.92	16.81	31.76	56.41		5.12	11.96	20.28	38.30	68.00
	Revolutions ..	2781	1390	927	927	696		3357	1678	1119	1119	839
340	Horse Power..	3.78	8.82	14.94	26.46	47.00	490	6 54	15.26	25.80	45.79	81.33
	Cubic Feet....	6.90	16.12	27.31	48.35	85.88		8.29	19.35	32.98	58.05	103.10
	Miner's Inches.	4.31	10.07	17.06	32.24	57.26		5.18	12.09	20.61	38.70	68.74
	Revolutions...	2823	1411	941	941	706		3390	1695	1130	1130	848
350	Horse Power..	3.94	9.21	15.61	27.64	49.09	500	6.74	15.73	26.66	47.20	83.83
	Cubic Feet....	7.00	16.35	27.71	49.06	87.14		8.37	19.54	33.12	58.64	104.15
	Miner's Inches.	4.37	10.21	17.32	32.70	58.09		5.23	12.21	20.72	39.09	69.41
	Revolutions ...	2865	1432	955	955	716		3426	1713	1142	1142	856
360	Horse Power..	4.10	9.61	16.28	28.83	51.21	520	7.06	19.57	28.16	50.05	88.90
	Cubic Feet....	7.10	16.58	28.10	49.75	88.37		8.43	23.38	33.64	59.80	106.21
	Miner's Inches.	4.43	10.36	17.56	33.17	58.91		5.62	15.58	22.42	39.86	70 81
	Revolutions.. .	2907	1453	969	969	726		3492	1746	1164	1164	873
370	Horse Power..	4.29	10.01	16.97	30.04	53.36	540	7.47	20.72	29.80	52.97	94.08
	Cubic Feet....	7.20	16.81	28.49	50.44	89.59		8.59	23.83	34.28	60.94	108.24
	Miner's Inches	4.50	10.50	17.75	33.63	59.73		5.72	15.84	22.85	40.63	72.16
	Revolutions...	2946	1473	982	982	736		3561	1780	1187	1187	890
380	Horse Power..	4.46	10.42	17.66	31.27	55.54	560	7.89	21.87	31.47	55.94	99.35
	Cubic Feet....	7.30	17.04	28.88	51.12	90.80		8.75	24.26	34.91	62.06	110.23
	Miner's Inches.	4.56	10.65	18.03	34.08	60.53		5.72	16.17	23.27	41.37	73.48
	Revolutions...	2985	14.92	995	995	746		3624	1812	1208	1208	906
390	Horse Power	4.64	10.83	18.36	32.51	57.75	580	8.31	23.05	33.18	58.96	104.73
	Cubic Feet....	7.39	17.26	29.25	51.79	91.98		8.90	24.69	35.53	63.16	112.18
	Miner's Inches.	4.61	10.78	18.25	34.53	61.32		5.93	16.46	23.68	42.10	74.78
	Revolutions...	3024	1512	1008	1008	756		3690	1844	1230	1230	922
400	Horse Power..	4.82	11.25	19.07	33.77	59.98	600	8.75	24.26	34.90	62.04	110.19
	Cubic Feet....	7.49	17.48	29.63	52.45	93.16		9.06	25.12	36.13	64.24	114.09
	Miner's Inches.	4.68	10.92	18.51	34.96	62.10		6.04	16.74	24.08	42.82	76.06
	Revolutions.. .	3063	1531	1021	1021	765		3753	1876	1251	1251	938
410	Horse Power..	5.00	11.68	19.79	35.04	62.24	650	9.87	27.85	39.36	69.95	124.25
	Cubic Feet....	7.58	17.70	30.00	53.10	94.31		9.43	26.14	37.61	66.86	118.75
	Miner's Inches.	4.73	11.06	18.75	35.40	62.87		6.28	17.42	25.07	44.57	79.17
	Revolutions...	3102	1551	1034	1034	775		3606	1952	1302	1302	976
420	Horse Power..	5.19	12.11	20.52	36.33	64.54	700	11.02	30.57	43.99	78.18	138.86
	Cubic Feet ...	7.67	17.91	30.36	53.74	95.46		9.78	27.13	39.03	69.38	123.23
	Miner's Inches.	4.79	11.19	18.93	35.83	63.64		6.52	18.08	26.02	46.25	82.16
	Revolutions ..	3141	1570	1047	1047	785		4053	2026	1351	1351	1013
430	Horse Power.	5.37	12.54	21.26	37.64	66.86	750	12.23	33.91	48.78	86.70	154.00
	Cubic Feet....	7.76	18.12	30.72	54.38	96.59		10.12	28.08	40.40	71.82	127.56
	Miner's Inches.	4.85	11.31	19.18	36.25	64.39		6.75	18.72	26.93	47.88	85.04
	Revolutions...	3177	1588	1059	1059	794		4197	2098	1309	1309	1049
440	Horse Power..	5.56	12.98	22.01	38.96	69.20	800	13.47	37.35	53.73	95.52	169.66
	Cubic Feet....	7.85	18.33	31.07	55.01	97.70		10 46	29.00	41.72	74.17	131.74
	Miner's Inches	4.90	11.45	19.41	36.66	65.13		6.97	19.33	27.81	49.45	87.83
	Revolutions ..	3213	1606	1071	1071	803		4332	2166	1444	1444	1083
450	Horse Power..	5.75	13.43	22.76	40.79	71.57	900	16.07	44 57	64 12	113.98	202.45
	Cubic Feet	7.94	18.54	31.42	55.63	98.81		11.09	30.76	44.25	78.67	139.74
	Miner's Inches.	4.96	11.58	19.65	37.08	65.87		7.39	20.50	29.50	52.45	93.16
	Revolutions...	3249	1624	1083	1083	812		4596	2298	1532	1532	1149
460	Horse Power .	5.95	13.88	23.53	41.65	73.97	1000	18.82	52.20	75.11	133.50	237.12
	Cubic Feet....	8.03	18.74	31.77	56.24	99.90		11.69	32.42	46.65	82.93	147.30
	Miner's Inches.	5 01	11.71	19.79	37.50	66.60		7.79	21.61	31.10	55.29	98.20
	Revolutions ..	3285	1642	1095	1095	821		4815	2420	1615	161	1210

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24''	36''	48''	60''	72''	8 ft.	10 ft	12 ft.
10	Horse Power..	.23	.53	.94	1.45	2.11	3 76	5.82	8 47
	Cubic Feet....	14.57	33.09	58.74	91.08	132.06	235.25	364.32	529.78
	Miner's Inches.	9.70	22.06	19.58	60.72	88.04	156.82	242.80	176.59
	Revolutions...	121	81	61	4	41	30	24	20
15	Horse Power..	.42	.97	1.74	2.67	3.88	6.90	10.70	17.35
	Cubic Feet....	18.03	40.52	72.50	111.54	161.73	288.14	446.16	723.15
	Miner's Inches	12.02	27.00	48.32	74 36	107.82	192.08	297.44	482.00
	Revolutions ..	148	99	74	59	49	37	30	25
20	Horse Power..	.66	1.50	2.64	4.18	6.00	10.64	16.48	23.80
	Cubic Feet....	20.83	46 93	83.32	130.36	187.72	332.70	515.04	748.95
	Miner's Inches.	13.88	31.28	55.52	86.90	125.12	221.80	343.40	499 20
	Revolutions...	171	114	85	70	57	43	34	29
25	Horse Power..	.91	2.09	3.64	5.75	8.35	14.88	23.00	33.50
	Cubic Feet....	23.04	52.31	91.20	144.00	208.80	372.00	576.00	837.60
	Miner's Inches	15.20	34.88	60.80	96.00	139.20	248 00	384.00	558.40
	Revolutions ..	195	129	98	77	65	44	38	32
30	Horse Power.	1.22	2.76	4.88	7.69	11 04	19.53	30.00	43.80
	Cubic Feet....	25.51	57.44	102.04	159.66	229 76	407.03	630.00	916.47
	Miner's Inches	17 00	38.28	68.00	106.44	153.12	271.34	420.00	611.00
	Revolutions...	209	139	104	83	69	52	41	35
35	Horse Power..	1.42	3.46	6.12	9.53	13.79	24.64	38.11	55.44
	Cubic Feet....	25.53	61.84	109.79	170.22	246.81	439.73	680.80	990.11
	Miner's Inches.	17.02	41.22	73.20	113.40	164.54	293.20	453.80	660.06
	Revolutions...	226	151	115	92	75	57	46	38
40	Horse Power..	1 89	4 24	7.58	11.85	16.96	30.08	46.60	67.60
	Cubic Feet....	29.46	66.36	107.84	184.36	265.44	470.27	728.16	1058.86
	Miner's Inches.	19.64	44.24	78.56	122.91	176.96	313.50	485.44	705.90
	Revolutions...	242	161	121	96	80	62	49	40
45	Horse Power ..	2.20	5.04	9 00	13.50	20.16	35.86	55.57	80.55
	Cubic Feet....	30.87	70.10	124.45	193.00	280.00	498.48	771.84	1122.38
	Miner's Inches.	20.50	46.72	82.96	128.64	186.52	332.32	514.56	748.24
	Revolutions...	257	174	130	103	86	65	52	42
50	Horse Power..	2.65	5.98	10.60	16.63	23.93	42.05	65.00	94.50
	Cubic Feet....	32.93	74.17	131.72	206.13	296.70	525.90	814.32	1184.15
	Miner's Inches.	21.95	49.45	87.80	137.42	197.80	350 60	542 88	789.40
	Revolutions...	270	180	135	108	90	69	55	46
55	Horse Power..	3.00	6.82	9.47	18.70	27 50	48 51	74 80	110.00
	Cubic Feet....	34.14	77.54	107.65	213.42	309.46	551.33	853.68	1244.95
	Miner's Inches.	22.76	51.68	71.76	142.28	206.30	367.60	569.12	829.30
	Revolutions...	283	192	144	115	96	72	57	48
60	Horse Power.	3.48	7.84	13 94	21.77	31.39	55.20	85.62	124.50
	Cubic Feet....	36.68	81.25	144.32	225.80	325.00	576.00	892.00	1297.00
	Miner's Inches.	24.05	54.16	96.20	150.52	216.64	384.00	594.56	864.60
	Revolutions ..	296	197	148	118	98	75	60	50
65	Horse Power.	3.90	8.45	15.28	24.05	30 14	62.40	96.20	140.40
	Cubic Feet....	37.14	81.24	147.00	232.14	336.60	600.00	928.50	1350.20
	Miner's Inches.	24.76	54 16	98.02	154.76	224.40	400.00	619.04	900.00
	Revolutions...	314	209	157	125	104	79	62	52
70	Horse Power..	4.39	9.88	17.58	27.51	39 52	70.00	107.80	157.50
	Cubic Feet....	38.97	87.76	155.88	243.89	351.04	624.00	966.24	1405.17
	Miner's Inches	25.98	58 52	103.92	162 60	234.08	416.00	644.16	936.60
	Revolutions...	320	213	160	130	106	81	64	54
75	Horse Power..	4.83	10.97	18.90	30.00	43.35	75.60	120.00	173.40
	Cubic Feet ...	40.32	91.45	157.96	249.42	361.65	631.84	997.68	1446.60
	Miner's Inches.	26.88	60.96	105 30	166 28	241.00	421.20	665.12	964.00
	Revolutions...	337	224	169	134	112	84	67	56
80	Horse Power..	5.36	12.04	21.44	33.54	48.16	85.76	134.16	192.64
	Cubic Feet....	41.66	93.84	166.64	260.73	375.36	666.56	1042.92	1501.44
	Miner's Inches.	27.77	62.56	111.08	173.82	250.24	444.32	695 28	1000.96
	Revolutions ..	342	228	171	137	114	87	69	58
85	Horse Power..	5.87	13.22	23.48	36.79	52 88	93.92	147.16	211.52
	Cubic Feet....	42.92	96.68	171.68	268.64	386 72	686.72	1074.56	1546.88
	Miner's Inches.	28.61	64.44	114 44	179.08	257.76	457.76	716.32	1031.04
	Revolutions ..	359	239	179	144	119	89	71	59

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24''	36''	48''	60''	72''	8 ft.	10 ft.	12 ft.
90	Horse Power..	6.39	14.40	25.59	40.04	57.60	102.36	160.16	230.40
	Cubic Feet....	44.19	99.52	176.75	276.55	398.08	707.00	1106.20	1592.32
	Miner's Inches.	29.46	66.32	117.83	184.36	265.28	471.32	737.44	1061.12
	Revolutions...	363	242	181	145	121	93	73	62
95	Horse Power..	6.94	15.62	27.76	43.44	62.48	111.04	173.76	249.92
	Cubic Feet....	45.38	102.20	181.52	284.03	408.80	726.08	1136.12	1635.20
	Miner's Inches.	30.24	68.12	120.96	189.34	272.48	483.84	757.36	1089.92
	Revolutions	378	252	189	151	126	95	74	63
100	Horse Power..	7.49	16.84	29.93	46.85	67.36	119.72	187.40	269.44
	Cubic Feet....	46.58	104.88	186.32	291.51	419.52	745.28	1166.04	1678.08
	Miner's Inches.	31.05	69.93	124.21	194.34	279.72	496.84	777.36	1118.88
	Revolutions...	382	255	191	152	127	96	77	64
105	Horse Power..	8.06	18.14	32.24	50.48	72.56	128.96	201.92	290.24
	Cubic Feet ...	47.71	107.44	190.84	298.62	429.76	763.36	1194.48	1719.04
	Miner's Inches.	31.80	71.63	127.20	199.08	286.52	508.80	796.32	1146.08
	Revolutions...	391	261	196	156	130	99	79	66
110	Horse Power..	8.64	19.44	34.58	54.11	77.76	138.32	216.44	311.04
	Cubic Feet....	48.85	110.00	195.41	305.73	440.00	781.64	1222.92	1760.00
	Miner's Inches.	32.56	73.33	130.27	203.82	293.32	521.08	815.28	1173.28
	Revolutions...	401	267	200	160	133	101	80	67
115	Horse Power..	9.24	20.81	36.96	57.88	83.24	147.84	231.52	332.96
	Cubic Feet....	50.00	112.45	200.00	312.53	449.80	800.00	1250.12	1799.20
	Miner's Inches.	33.00	74.96	132.00	208.35	299.84	528.00	833.40	1199.36
	Revolutions .	410	273	205	164	136	103	82	69
120	Horse Power..	9.85	22.18	39.41	61.66	88.75	157.64	246.64	355.00
	Cubic Feet....	51.02	114.91	204.10	319.33	459.64	816.40	1277.32	1838.56
	Miner's Inches.	34.01	76.60	136.06	212.89	306.43	544.24	851.56	1225.72
	Revolutions...	419	279	209	167	139	105	83	70
125	Horse Power..	10.48	23.60	41.92	65.59	94.40	167.68	262.36	377.60
	Cubic Feet....	52.06	117.25	208.24	325.85	469.00	832.96	1303.40	1876.00
	Miner's Inches.	34.70	78.16	138.83	217.23	312.64	555.20	868.92	1250.56
	Revolutions...	428	285	214	171	142	108	86	72
130	Horse Power..	11.11	25.02	44.46	69.53	100.08	177.84	278.12	400.32
	Cubic Feet....	53.10	119.60	212.43	332.37	478.41	849.72	1329.48	1913.64
	Miner's Inches	35.40	79.73	141.62	221.58	318.94	566.48	886.32	1275.76
	Revolutions...	436	291	218	174	145	110	88	73
135	Horse Power..	11.76	26.49	47.04	73.62	105.96	188.16	294.48	423.84
	Cubic Feet....	54.10	121.86	216.40	338.64	487.44	865.60	1354.56	1949.76
	Miner's Inches.	36.07	81.24	144.28	225.76	324.88	577.12	903.04	1299.52
	Revolutions...	445	297	222	178	148	112	89	74
140	Horse Power..	12.41	27.96	49.64	77.71	111.85	198.56	310.84	447.40
	Cubic Feet....	55.11	124.12	220.44	344.92	496.48	881.76	1379.68	1985.92
	Miner's Inches.	36.74	82.72	146.96	229.94	330.88	587.84	919.76	1323.52
	Revolutions..	453	302	226	181	151	114	90	75
145	Horse Power..	13.09	29.48	52.36	81.96	117.92	209.44	327.84	471.68
	Cubic Feet....	56.07	126.29	224.28	350.97	505.16	897.12	1403.88	2020.64
	Miner's Inches.	37.38	84.18	149.52	233.99	336.72	598.08	935.96	1346.88
	Revolutions .	461	307	230	184	154	116	92	77
150	Horse Power .	13.77	31.01	55.08	86.22	124.04	220.32	344.88	496.16
	Cubic Feet....	57.04	128.47	228.19	357.02	513.90	912.76	1428.08	2055.60
	Miner's Inches.	38.03	85.64	152.12	238.05	342.59	608.48	952.20	1370.36
	Revolutions...	468	312	234	187	156	117	94	79
155	Horse Power..	14.47	32.58	57.88	90.58	130.32	231.52	362.32	521.28
	Cubic Feet....	57.98	130.57	231.92	362.87	522.28	927.68	1451.48	2089.12
	Miner's Inches.	38.65	87.05	154.60	241.93	348.20	618.40	967.72	1392.80
	Revolutions...	476	318	238	190	159	119	96	80
160	Horse Power..	15.17	34.16	60.68	94.94	136.65	242.72	377.76	546.60
	Cubic Feet....	58.92	132.68	235.68	368.73	530.75	942.72	1474.92	2123.00
	Miner's Inches.	39.28	88.46	157.12	245.82	353.84	628.48	983.28	1415.36
	Revolutions...	484	323	242	193	161	121	97	81
165	Horse Power..	15.89	35.79	63.56	99.46	143.16	254.24	397.84	572.64
	Cubic Feet....	59.82	134.72	239.28	374.40	538.88	957.12	1497.60	2155.52
	Miner's Inches.	39.88	89.82	159.52	249.60	359.28	838.08	998.40	1437.12
	Revolutions...	491	329	247	197	164	123	99	82

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24''	36''	48''	60''	72''	8 ft.	10 ft.	12 ft.
170	Horse Power..	16.61	37.42	66 46	103.99	149.68	265.84	415.90	598.72
	Cubic Feet....	60.73	136.77	242.93	380.08	547.08	971.72	1520.32	2188.32
	Miner's Inches.	40.48	91.18	161.95	253.38	364.72	647.80	1013.52	1458.88
	Revolutions...	498	332	249	199	166	125	99	83
175	Horse Power..	17 35	39 09	69.40	108.64	156.36	277.60	434.56	625.44
	Cubic Feet....	61.61	138 75	246.44	385.59	555.00	985.76	1542 36	2220.00
	Miner's Inches	41.07	92.50	164.28	257.05	370.00	657.12	1028.20	1480.00
	Revolutions ..	506	337	253	203	169	126	102	85
180	Horse Power..	18.10	40.77	72.41	113.30	163.08	289.64	453 20	652.32
	Cubic Feet....	62 49	140.74	249 97	391.10	562.96	999.80	1564.40	2251.84
	Miner's Inches	41.66	93.82	166.64	260.73	375.29	666.56	1042.92	1501 16
	Revolutions...	513	342	256	206	171	128	103	86
185	Horse Power..	18.86	42.49	75.44	118.08	169 96	301.76	472.32	679.84
	Cubic Feet....	63.34	142.66	253.36	396.45	570 64	1013.44	1585 80	2282.56
	Miner's Inches	42.23	95.10	168.92	264.30	380.40	675.68	1057.20	1521 60
	Revolutions ...	520	347	260	209	174	130	105	87
190	Horse Power..	19.63	44.21	78.53	122.87	176.86	314.12	491.48	707.44
	Cubic Feet....	64.20	144.59	256.82	401.81	578.38	1027.28	1607.24	2313.52
	Miner's Inches	42.80	96.39	171.21	267.87	385.58	684.84	1071.48	1442.32
	Revolutions...	527	351	263	211	176	132	106	88
195	Horse Power..	20.41	45.98	81.64	127.78	183.92	326.56	511.12	735.68
	Cubic Feet....	65.03	146.47	260.12	407.03	585 88	1040.48	1628.12	2343.52
	Miner's Inches	43.35	97.64	173.40	271.35	390.56	693.60	1085.40	1562.24
	Revolutions...	534	356	267	214	178	134	107	89
200	Horse Power..	21.20	47.75	84.81	132 70	191.00	339.24	530.80	764.00
	Cubic Feet....	65.87	148.35	263.49	412.25	593.40	1053 96	1649.00	2373.60
	Miner's Inches.	43.91	98.90	175.66	274.83	395.60	702.64	1099.32	1582.40
	Revolutions...	540	360	270	216	180	135	108	90
205	Horse Power	22.00	49.56	88 00	137.74	198.24	352.00	550.96	792.96
	Cubic Feet....	66.68	150.18	266.72	417.34	600.72	1066.88	1669.36	2402.88
	Miner's Inches.	44.45	100.12	177.80	278.22	400.48	278.22	1112.88	1601.92
	Revolutions...	547	365	274	219	183	137	110	91
210	Horse Power..	22.81	51.38	91.26	142.78	205.52	365.04	571.12	822 08
	Cubic Feet....	67.50	152.01	270.00	422 44	608.66	1080 00	1689.76	2432.24
	Miner's Inches.	45.00	101.34	180.00	281 62	405.37	720.00	1126.48	1621.48
	Revolutions...	553	369	277	222	184	139	111	92
215	Horse Power..	23.63	53.23	94.52	147.94	212.92	378.08	591.76	851.68
	Cubic Feet....	68.29	153.80	273.16	427.41	615.20	1092.64	1709 64	2460.80
	Miner's Inches.	45.52	102.53	182.08	284.93	410.12	728.32	1139.72	1640.48
	Revolutions...	560	364	280	224	187	141	112	94
220	Horse Power..	24.46	55.09	97.85	153.10	220.36	391 40	612.40	881.44
	Cubic Feet....	69.08	155.59	276.35	432.38	622.36	1105.40	1729.52	2489.44
	Miner's Inches.	46.05	103 72	184.23	288.25	414.91	736.92	1153.00	1659.64
	Revolutions ..	567	378	283	226	189	142	113	95
225	Horse Power..	25.30	56.99	101.20	158.38	227 96	404.80	633.52	911 84
	Cubic Feet....	69 86	157.33	279.44	437 23	629.32	1117.76	1748.92	2517.28
	Miner's Inches.	46.57	104.89	186.28	291.49	419.56	745.12	1165.96	1678 24
	Revolutions...	574	382	287	229	191	144	115	96
230	Horse Power..	26.15	58.89	104 60	163.66	235.56	418.40	654.64	942.24
	Cubic Feet....	70 64	159.08	282.56	442.09	636.35	1130.24	1768.36	2545.40
	Miner's Inches.	47.09	106.06	188 38	294.73	424.24	753.52	1178.92	1696.96
	Revolutions...	580	386	290	232	193	145	116	97
235	Horse Power..	27.01	60.83	108.04	169.05	243.32	432.16	676.20	973.28
	Cubic Feet .	71.40	160.79	285.60	446.84	643.16	1142.40	1787.36	2572.64
	Miner's Inches.	47.59	107.20	190.36	297.90	428.80	761.44	1191.60	1715.20
	Revolutions...	586	391	293	235	195	147	118	98
240	Horse Power..	27.87	62.77	111.50	174.45	251.10	446.00	697.80	1004.40
	Cubic Feet....	72.16	162.50	288.64	451.60	650.03	1154.56	1806.40	2600.12
	Miner's Inches.	48.10	108.34	192.42	301.07	433.36	769.68	1204.28	1733.44
	Revolutions ..	592	395	296	237	197	148	110	99
245	Horse Power..	28.75	64.75	115.00	179.96	259.00	460.00	719.84	1036.00
	Cubic Feet....	72.90	164.18	291.60	456.25	656.72	1166.40	1825.00	2626.88
	Miner's Inches.	48.59	109.45	194.36	304.17	437.80	777.44	1216.68	1751.20
	Revolutions ..	599	399	299	239	200	149	120	100

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24″	36″	48″	60″	72″	8 ft.	10 ft.	12 ft.
250	Horse Power..	29.63	66.74	118.54	185.47	266.96	474.16	741.88	1067.84
	Cubic Feet....	73.64	165.86	294.59	460.91	663.45	1178.36	1843.64	2653.80
	Miner's Inches.	49.09	110.57	196.39	307.27	442.30	785.56	1229.08	1769.20
	Revolutions..	605	403	302	241	202	151	121	101
255	Horse Power..	30.53	68.76	122.12	191.09	275.04	488.48	764.36	1100.16
	Cubic Feet....	74.37	167.50	297.48	465.47	670.00	1189.92	1861.88	2680.00
	Miner's Inches.	49.58	111.66	198.32	310.31	446.64	793.28	1241.24	1786.56
	Revolutions	611	407	305	244	204	153	122	102
260	Horse Power..	31.43	70.78	125.72	196.71	283.15	502.88	786.84	1132.60
	Cubic Feet....	75.10	169.14	300.43	470.04	676.59	1201.72	1880.16	2706.36
	Miner's Inches.	50.07	112.76	200.28	313.36	451.05	801.12	1253.44	1804.20
	Revolutions...	617	411	308	247	206	154	124	103
265	Horse Power..	32.35	72 84	129 40	202.44	291.36	517.60	809.76	1165 44
	Cubic Feet ...	75.81	170 75	303.24	474.52	683.00	1212.96	1898.08	2732.00
	Miner s Inches.	50.54	113.83	202.16	316.34	455.32	808,64	1265 36	1821 28
	Revolutions...	623	415	311	249	208	156	125	104
270	Horse Power..	33.26	74.90	133.05	208.17	299.63	532.20	832.68	1198 52
	Cubic Feet...	76 53	172.36	306.15	479.00	689.46	1224.60	1916.00	2757.84
	Miner's Inches.	51.02	114.91	204.10	319.33	459.64	816.40	1277.32	1838.56
	Revolutions...	628	419	314	251	209	157	126	105
275	Horse Power..	34.19	77.00	136.76	214.00	308.00	547.04	856.00	1232.00
	Cubic Feet....	77.23	173.94	308.92	483.39	695.76	1235.68	1933.56	2783.04
	Miner's Inches.	51.15	115 96	204 60	322.26	463.84	818 40	1289.04	1855.36
	Revolutions	634	423	317	253	211	159	127	106
280	Horse Power..	35.12	79.11	140.51	219.84	316.44	562.04	879.36	1265.76
	Cubic Feet....	77.94	175.53	311.77	487.79	702.12	1247.08	1951.16	2808 48
	Miner's Inches.	51.29	117.02	205.18	325.19	468.06	820.72	1300.76	1872.24
	Revolutions...	639	427	319	255	213	160	128	107
285	Horse Power..	36.07	81.24	144.28	225.78	324.96	577 12	903.12	1299.84
	Cubic Feet....	78.63	177.08	314.52	492.10	708.32	1258 08	1968.40	2833.28
	Miner's Inches.	52.08	118.05	208.32	328.06	472.20	825 28	1312.24	1888.80
	Revolutions...	645	431	322	258	215	161	129	108
290	Horse Power..	37 02	83.38	148.10	231.73	333.55	592.40	926.92	1334.20
	Cubic Feet....	79.32	178 64	317.29	496.42	714.56	1269.16	1985.68	2858.24
	Miner's Inches.	52.88	119.09	211.52	330.94	476.36	846 08	1323.76	1905.44
	Revolutions...	651	434	325	260	217	163	130	109
295	Horse Power..	37.98	85 55	151.92	237.77	342 20	607.68	951 68	1368 80
	Cubic Feet....	79.99	180.16	319.96	500.66	720.64	1279.84	2002.64	2882.56
	Miner's Inches	53.33	120.10	213.32	333.77	480.40	853.28	1335.08	1921.60
	Revolutions...	657	438	328	263	219	164	132	110
300	Horse Power..	38.95	87.73	155.83	243.82	350.94	623.32	975.28	1403.76
	Cubic Feet....	80.67	181.69	322.71	504.91	726.76	1290.84	2019.64	2907.04
	Miner's Inches.	53.78	121.12	215.14	336.60	484.51	860.56	1346.40	1938.04
	Revolutions..	663	442	331	265	221	166	133	111
305	Horse Power..	39.93	89.94	159.72	249.96	359.76	638.88	999.84	1439.04
	Cubic Feet....	81.34	183.19	325.36	509.68	732.76	1301.44	2036.32	2931.04
	Miner's Inches.	54.22	72.12	216.88	339.38	288.48	867.52	1357.52	1153.92
	Revolutions ..	669	446	334	267	223	167	134	112
310	Horse Power..	40.92	92.16	163.69	256.11	368.64	654.76	1024.44	1474.56
	Cubic Feet....	82.01	184.69	328.04	513.25	738.78	1312.16	2053.00	2955.12
	Miner's Inches.	54.67	123.12	218.69	342.17	492.51	874.76	1368.68	1970.04
	Revolutions...	674	449	337	269	224	168	135	112
315	Horse Power..	41.91	94.40	167.64	262.35	377.60	670.56	1049.40	1510.40
	Cubic Feet....	82.66	186.17	330.64	517.35	744.68	1322.56	2069.40	2978.72
	Miner's Inches.	55.11	124.11	220.44	344.90	496.44	881.76	1379.60	1985.76
	Revolutions...	680	453	340	272	226	170	136	113
320	Horse Power ..	42.91	96.65	171.68	268.60	386.62	686.72	1074.40	1546.48
	Cubic Feet....	83.32	187.65	333.24	521.46	750.60	1333.16	2085.84	3002.40
	Miner's Inches	55.55	125.10	222.19	347.64	500.40	888.76	1390.56	2001.60
	Revolutions..	685	456	342	274	228	171	137	114
325	Horse Power..	43.92	98.93	175.68	274.94	395.72	702.72	1099.76	1582.88
	Cubic Feet....	83.96	189.10	335.84	525.50	756.40	1343.36	2102.00	3025.60
	Miner's Inches.	55.98	126.07	223.92	351.33	504.28	895.68	1405.32	2017.12
	Revolutions...	691	460	344	276	230	172	138	115

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24''	36''	48''	60''	72''	8 ft	10 ft.	12 ft.
330	Horse Power..	44.94	101.22	179.72	281 29	404.89	718.88	1125.16	1619.56
	Cubic Feet....	84.61	190.56	338.46	529.55	762.24	1353.84	2118.20	3048.96
	Miner's Inches.	56.41	127.04	225.64	353.03	508.16	902.56	1412.12	2032.64
	Revolutions..	696	463	346	277	231	173	139	116
335	Horse Power..	45.97	103.54	183.88	287.73	414.16	735.52	1150.92	1656.64
	Cubic Feet....	85.24	191.99	340.96	533.53	797.96	1363.84	2134.12	3191.84
	Miner's Inches.	56.83	128.01	227.32	355.68	552.04	909.28	1422.72	2208.16
	Revolutions	701	467	350	280	233	175	140	117
340	Horse Power..	47.00	105.86	188.02	294.18	423.44	752.08	1176.72	1693.76
	Cubic Feet....	85.88	193.42	343.55	537.51	773.71	1374.20	2150.04	3094.84
	Miner's Inches.	57.26	128.98	229.04	358.34	515.93	916.16	1433.36	2063.72
	Revolutions ...	706	470	353	282	235	177	141	118
345	Horse Power..	48.04	108.21	192.16	300.71	432.84	768.64	1202.84	1731.36
	Cubic Feet....	88.51	194.83	346.04	541 43	779.32	1384.16	2165.72	3117.28
	Miner's Inches.	57.67	129.90	230.68	360.95	519.66	922.72	1443.80	2078.40
	Revolutions..	711	474	356	284	237	178	142	119
350	Horse Power..	49.09	110.56	196.38	307.25	442.27	785.52	1229.00	1769.08
	Cubic Feet....	87.14	196.25	348.57	545.36	785.00	1394.28	2181.44	3140.00
	Miner's Inches.	58.09	130.83	232 38	363.57	523.32	929.52	1454.28	2093.28
	Revolutions...	716	477	358	275	238	179	143	119
355	Horse Power..	50.15	112.95	200.60	313.88	451.80	802.40	1255.52	1807.20
	Cubic Feet....	87.75	197.64	351.00	549.23	790.56	1404.00	2196.92	3162.24
	Miner's Inches.	58 50	131.75	234.00	366.15	527.00	936.00	1464.60	2108.00
	Revolutions.	721	481	361	288	240	180	144	120
360	Horse Power..	51.21	115.34	204.86	320.52	461.36	819.44	1282.08	1845.44
	Cubic Feet....	88.37	199.03	353.51	553.10	796.14	1414.04	2212.40	3184.56
	Miner's Inches.	58.91	132.68	235 64	368 73	530 75	942.56	1474.92	2123 00
	Revolutions...	726	484	363	290	242	181	145	121
365	Horse Power..	52.29	117.76	209.16	330.24	471.04	836.64	1320.96	1884.16
	Cubic Feet....	88.98	200.40	355.92	556.91	801.60	1423.68	2227.64	3206.40
	Miner's Inches.	59 32	133.60	237.28	371.27	534.40	949.12	1485.08	2137.60
	Revolutions...	731	488	366	292	244	183	146	122
370	Horse Power..	53.36	120.18	213.45	333.97	480 72	853.80	1335.88	1922.88
	Cubic Feet....	89 59	201.78	358.39	560.73	807.12	1433.56	2242.92	3228.48
	Miner's Inches.	59.73	134.52	238.92	373.82	538 08	955.68	1495.28	2152.32
	Revolutions..	736	491	368	294	245	134	147	123
375	Horse Power..	54.45	122.63	217.80	343.78	490.52	871.20	1375.12	1962.08
	Cubic Feet....	90.19	203.13	360 76	564.49	812.52	1443.04	2257.96	3250.08
	Miner's Inches.	60.13	135.42	240.52	376.32	541.68	962 08	1505.28	2166.72
	Revolutions..	741	494	371	296	247	185	148	124
380	Horse Power..	55 54	125.08	222.16	347.60	500 33	888.64	1390.40	2001.32
	Cubic Feet....	90.80	204.48	363.20	568.25	817.95	1452.80	2273.00	3271 80
	Miner's Inches.	60.53	136 32	242.13	378.83	545.29	968.52	1515.32	2181.16
	Revolutions...	746	497	373	298	248	186	149	124
385	Horse Power..	56.64	127.56	226.56	354.50	510 24	906.24	1418.00	2040.96
	Cubic Feet....	91 39	205.82	365 56	571.96	823.28	1462 24	2287.84	3293.12
	Miner's Inches.	60.92	137.21	487.40	381.31	548.84	1949.60	1525.24	2195.36
	Revolutions ..	751	501	376	300	250	188	150	125
390	Horse Power..	57.75	130.05	231.00	361.41	520.20	924 00	1445.64	2080.80
	Cubic Feet....	91.98	207.16	367.95	575.68	828.64	1471.80	2302.72	3314.56
	Miner's Inches.	61 32	138.11	245.28	383.79	552 43	981.12	1535.16	2209.72
	Revolutions...	756	504	378	302	252	189	151	126
395	Horse Power..	58 86	132.56	235 44	368.80	530 24	941.76	1475 20	2120 96
	Cubic Feet....	92.57	208.48	370.28	579.35	833.92	1481.12	2317.14	3335.68
	Miner's Inches.	61.71	138.97	246.84	386.23	555.88	987.36	1544.82	2223.52
	Revolutions...	761	507	380	304	254	190	152	127
400	Horse Power..	59.98	135.08	239.94	375.40	540.35	959.76	1501.60	2161 40
	Cubic Feet....	93.16	209.80	372.64	583.02	839.20	1490.56	2332.08	3356.80
	Miner's Inches.	62.10	139.84	248.40	388.68	559.35	993.60	1554.72	2237.40
	Revolutions...	765	510	382	306	255	191	153	128
405	Horse Power..	61.11	137.63	244.44	382.48	550.52	977.76	1529.92	2202.08
	Cubic Feet....	93.73	211.10	374.92	586.64	844.40	1499.68	2346.56	3377.60
	Miner's Inches.	62.48	140.72	249.92	391.09	562.88	999.68	1564 36	2251.52
	Revolutions...	770	514	385	308	257	193	154	129

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24''	36''	48''	60''	72''	8 ft.	10 ft.	12 ft.
410	Horse Power..	62.24	140.18	248.99	389.57	560.75	895.90	1558.28	2243.00
	Cubic Feet....	94.31	212.40	377.26	590.26	849.63	1509.04	2361.04	3398.52
	Miner's Inches.	62.87	141.60	251.51	393.50	566.41	1006.04	1574.00	2265.64
	Revolutions. .	775	517	387	309	258	193	154	127
415	Horse Power..	63.39	142.76	253.56	396.74	571.04	1014.24	1586.96	2284.16
	Cubic Feet....	94.88	213.69	379.52	593.83	854.76	1518.08	2375.32	3419.04
	Miner's Inches.	63.15	142.46	252.60	395.89	569.84	1010.40	1583.56	2279.36
	Revolutions	780	520	390	311	260	195	156	130
420	Horse Power..	64.54	145.34	258 16	403.91	581.39	1032.64	1615.64	2325.56
	Cubic Feet....	95.46	214.98	381.84	597.41	859.93	1527.36	2389.64	3439.72
	Miner's Inches.	63.64	143.32	254.56	398.28	573.28	1018.24	1593.12	2293.12
	Revolutions ...	785	523	392	313	261	196	157	131
425	Horse Power..	65.70	147.95	262.80	411.16	591.80	1051.20	1644.64	2367.20
	Cubic Feet ...	96.02	216.25	384.08	600.94	865.00	1536.32	2403 76	3460.00
	Miner s Inches.	64.01	144.16	256.04	400.63	576 64	1024.16	1602.52	2306.56
	Revolutions...	790	526	395	315	263	198	158	132
430	Horse Power..	66.86	150.57	267 44	418.42	602.28	1069.76	1673.68	2409 12
	Cubic Feet....	96.59	217.52	386.36	604.48	870.11	1545 44	2417.92	3480.44
	Miner's Inches.	64.39	145.00	257.58	402.99	580.00	1030.32	1611 96	2320 00
	Revoluti ns	794	529	397	317	264	199	159	132
435	Horse Power..	68.03	153.21	272.12	425.76	612.84	1088.48	1703.04	2451.36
	Cubic Feet ..	97 14	218 78	388.56	607.97	875.12	1554.24	2431.88	3500.48
	Miner's Inches.	64.76	145.82	259 04	405.32	583.28	1036.16	1621.28	2333.12
	Revolutions	799	532	399	319	266	200	160	133
440	Horse Power..	69 20	155.85	276.82	433.11	623.40	1107.28	1732.44	2493.60
	Cubic Feet....	97.70	220.04	390.82	611.47	880.16	1563.28	2445.88	3520.64
	Miner's Inches	65.13	146.64	260.53	407 65	586.56	1042.12	1630.60	2346.24
	Revolutions...	803	535	401	320	267	201	160	134
445	Horse Power..	70.38	158.52	281.52	440.53	634 08	1126.08	1762.12	2536.32
	Cubic Feet....	98.25	221.28	393.00	614.92	885.12	1572.00	2459.68	3540.48
	Miner's Inches.	65.50	147.49	262.00	409.95	589.96	1048 00	1639.80	2359.84
	Revolutions...	808	538	404	322	269	202	161	135
450	Horse Power..	71 57	161.19	286.31	447.95	644 78	1145 24	1791.80	2579 12
	Cubic Feet....	98.81	222.52	395.24	618 38	890 11	1580 96	2473.52	3560.44
	Miner's Inches.	65 87	148.35	263.49	412.25	593.40	1053.96	1649.00	2373.60
	Revolutions...	812	541	406	324	270	203	162	135
455	Horse Power..	72.77	163.89	291.08	455.46	655.56	1164.32	1821 84	2622.24
	Cubic Feet....	99.35	223.75	397.40	621.80	895.00	1589 60	2487.20	3580.00
	Miner's Inches.	66.23	149.17	264.92	414.52	596.68	1059.68	1658.08	2386.72
	Revolutions.	817	544	408	326	272	204	163	136
460	Horse Power.	73.97	166.60	295.91	462.97	666.40	1183.64	1851.88	2665.60
	Cubic Feet....	99.90	224.98	399.61	625.22	899,95	1598.44	2500.88	3599.80
	Miner's Inches.	66 60	150.00	266.40	416 80	600.00	1065.60	1667.20	2400.00
	Revolutions..	821	547	410	327	273	205	164	137
465	Horse Power..	75.18	169.33	300.72	470.56	677 32	1202.88	1882.24	2709 28
	Cubic Feet....	100.44	226.20	401.76	628.60	904.80	1607 04	2514.40	3619.20
	Miner's Inches.	66.96	150 80	267.84	419.06	603 20	1071.36	1676.24	2412.80
	Revolutions ..	826	550	413	330	275	207	165	138
470	Horse Power..	76.40	172.06	305.61	478.15	688.25	1221.44	1912.60	2753 00
	Cubic Feet....	100.98	227.42	403.93	631.98	909 68	1615.72	2527.92	3608.72
	Miner's Inches.	67.32	151 61	269.28	421.32	606.44	1077.12	1685.28	2425.76
	Revolutions...	830	553	415	332	276	208	166	138
475	Horse Power..	77.62	174.82	310 48	485.82	699.28	1241.92	1943.28	2797.12
	Cubic Feet....	101.51	228.62	406.04	635.32	914.48	1624.16	2541.28	3657.92
	Miner's Inches.	67 66	152.40	269.64	424 55	609.60	1078 56	1698.20	2438.40
	Revolutions...	835	556	417	334	278	209	167	139
480	Horse Power..	78.85	177.58	315.42	493 49	710.33	1261.68	1973.96	2841.32
	Cubic Feet....	102.05	229.82	408.20	638.66	919 29	1632 80	2554.64	3677.16
	Miner's Inches.	68.00	153.20	272.12	425.78	612.80	1088 48	1703.12	2451.20
	Revolutions..	839	559	419	3 5	279	210	168	140
485	Horse Power..	80.09	180.37	320.36	501.24	721.48	1281.44	2004.96	2885 92
	Cubic Feet....	102.57	231.01	410.28	641.97	924.04	1641.12	2567.88	3 96.16
	Miner's Inches.	68.37	154.00	273.48	428.98	616.00	1093.92	1715.92	2464.00
	Revolutions...	844	562	422	337	281	211	169	14

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24''	36''	48''	60''	72''	8 ft.	10 ft.	12 ft.
490	Horse Power..	81.33	183.16	325.32	509.00	732.65	1301.28	2036.00	2930.60
	Cubic Feet....	103.10	232.20	412.43	645.28	928.83	1649.72	2581.12	3715.32
	Miner's Inches.	68.74	154.80	274.96	430.19	619.20	1099.84	1720.76	2476.80
	Revolutions...	848	565	424	339	282	212	169	141
495	Horse Power..	82.58	185.98	330.32	516.83	743.92	1321.28	2067.32	2975.68
	Cubic Feet....	103.62	233.38	414.48	648.55	933.52	1657.92	2594.20	3734.08
	Miner's Inches	69.07	155.58	276.28	432.37	622.32	1105.12	1729.48	2489.28
	Revolutions ..	852	568	426	341	284	213	171	142
500	Horse Power..	83.83	188.80	335.34	524.66	755.20	1341.36	2098.64	3020.80
	Cubic Feet	104.15	234.56	416.62	651.83	938.25	1666.48	2607.02	3753.00
	Miner's Inches	69.41	156.36	277.64	434.56	625.44	1110.56	1738.24	2501.76
	Revolutions...	856	571	428	342	285	214	171	143
510	Horse Power..	86.36	194.51	345.44	540.52	778.04	1381.76	2162.08	3112.16
	Cubic Feet....	105.18	236.88	420.72	658.29	947.52	1682.88	2633.12	3790.08
	Miner's Inches	70.11	157.91	280.44	438.86	631.64	1121.76	1755.44	2526.56
	Revolutions ..	865	577	432	346	288	216	173	144
520	Horse Power..	88.90	200.22	355.62	556.39	800.88	1422.48	2225.56	3203.52
	Cubic Feet....	106.21	239.21	424.87	664.74	956.84	1699.48	2658.96	3827.36
	Miner's Inches.	70.81	159.47	283.24	443.16	637.88	1132.96	1772.64	2551.52
	Revolutions...	873	582	436	349	291	218	175	146
530	Horse Power..	91.49	206.05	365.96	572.59	824.20	1463.84	2290.36	3296.80
	Cubic Feet....	107.22	241.48	428.88	671.07	965.92	1715.52	2684.28	3863.68
	Miner's Inches	71.48	160.99	285.92	447.38	643.96	1143.68	1789.52	2575.84
	Revolutions...	882	588	441	353	294	221	177	147
540	Horse Power..	94.08	211.88	376.33	588.80	847.52	1505.32	2355.20	3390.08
	Cubic Feet....	108.24	243.76	432.96	677.41	975.07	1731.84	2709.64	3900.28
	Miner's Inches.	72.16	162.51	288.64	451.61	650.04	1154.56	1806.44	2600.16
	Revolutions...	890	593	445	356	296	223	178	148
550	Horse Power	96.71	217.82	386.84	605.31	871.28	1547.36	2421.24	3485.12
	Cubic Feet....	109.23	246.00	436.92	683.62	984.00	1747.68	2734.48	3936.00
	Miner's Inches.	72.82	164.00	291.28	455.75	656.00	1165.12	1823.00	2624.00
	Revolutions...	898	599	449	359	299	225	179	150
560	Horse Power..	99.35	223.76	397.43	621.82	895.04	1589.72	2487.28	3580.16
	Cubic Feet....	110.23	248.24	440.91	689.84	992.96	1763.64	2759.36	3971.84
	Miner's Inches.	73.48	165.49	293.94	459.89	661.96	1775.76	1839.56	2647.84
	Revolutions ..	906	604	453	362	302	227	181	151
570	Horse Power..	102.04	229.81	408.16	638.62	919.24	1632.64	2554.48	3676.96
	Cubic Feet....	111.20	250.43	444.80	695.94	1001.72	1779.20	2783.76	4006.88
	Miner's Inches.	74.13	166.95	296.52	463.96	667.80	1186.08	1855.84	2671.20
	Revolutions...	914	610	457	366	305	229	183	153
580	Horse Power..	104.73	235.86	418.92	655.43	943.44	1675.68	2621.72	3773.76
	Cubic Feet....	112.18	252.63	448.71	702.04	1010.54	1794.84	2808.16	4042.16
	Miner's Inches.	74.78	168.42	299.14	468.03	673.69	1196.56	1872.12	2694.76
	Revolutions ..	922	615	461	369	307	232	185	154
590	Horse Power..	107.46	242.01	429.84	672.58	968.04	1719.36	2690.32	3872.16
	Cubic Feet....	113.13	254.79	452.52	708.04	1019.16	1810.08	2832.16	4076.64
	Miner's Inches.	75.42	169.86	301.68	472.03	679.44	1206.72	1888.12	2717.76
	Revolutions...	930	620	465	372	310	233	186	155
600	Horse Power..	110.19	248.16	440.77	689.63	992.65	1763.08	2758.52	3970.60
	Cubic Feet....	114.09	256.95	456.38	714.05	1027.80	1825.52	2856.20	4111.20
	Miner's Inches	76.06	171.30	304.24	476.03	685.20	1216.96	1904.12	2740.80
	Revolutions...	938	625	469	375	312	235	188	156
620	Horse Power..	115.61	259.56	462.44	719.21	1038.24	1849.76	2876.84	4152.96
	Cubic Feet .	115.31	260.79	461.24	722.82	1043.16	1844.96	2891.28	4172.64
	Miner's Inches.	76 87	173.86	307.48	481.87	695.44	1229.92	1927.48	2781.76
	Revolutions...	952	635	476	381	317	239	191	159
640	Horse Power..	121.04	270.97	484.16	748.80	1083.88	1936.64	2995.20	4335.52
	Cubic Feet....	116 53	264.63	466.12	731.59	1058.52	1864.48	2926.36	4234.08
	Miner's Inches.	77 69	176.42	310 76	487.72	705.68	1243.04	1950.88	2822.72
	Revolutions ..	966	644	483	387	322	242	194	161
660	Horse Power..	124.74	284.06	498.96	781.44	1136.24	1995.84	3125.76	4544.96
	Cubic Feet....	118.37	268.81	473.48	739.86	1075.24	1893.92	2959.44	4300 97
	Miner's Inches.	78.90	179.20	315.60	493.24	716.80	1262.40	3972.96	2867.20
	Revolutions .	982	655	491	391	328	246	196	164

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Risdon Water Wheel Tables

Giving Horse Powers, Miner's Inches, Cubic Feet of Water per minute and Revolutions per minute.

Head in Feet.		Size of Wheels.							
		24''	36''	48''	60''	72''	8 ft.	10 ft.	12 ft.
680	Horse Power..	131.80	298.39	527.20	825.25	1193.56	2108.80	3301.00	4774 24
	Cubic Feet....	120 80	273.17	483.20	755.56	1092.68	1932.80	3022.24	4370.72
	Miner's Inches.	80.53	182.11	322.12	503.71	728.44	1288.48	2014.84	2913.76
	Revolutions...	996	665	498	398	333	249	199	167
700	Horse Power..	138.86	312.73	555.46	869.06	1250.92	2221.84	3476.24	5003.68
	Cubic Feet....	123.23	277.54	492.95	771.26	1110.16	1971.80	3085.04	4440.64
	Miner's Inches.	82.16	185.02	328.63	514 18	740.09	1314.52	2056 72	2960.36
	Revolutions...	1013	675	506	405	337	253	202	169
725	Horse Power..	146.43	329.78	585.72	916 44	1319 12	2342.98	3665.76	5276.52
	Cubic Feet....	125.39	282.41	491. 6	784 79	1129.64	2006 40	3139 18	4518.58
	Miner's Inches	83.60	188.27	334.40	523.20	753.08	1337.58	2092.50	3012.36
	Revolutions...	1031	687	516	412	344	257	206	172
750	Horse Power..	151.00	346.83	616 03	963.82	1387.34	2464.12	3855.28	5549.36
	Cubic Feet....	127.56	287.28	510.25	798.33	1149.13	2041.00	3193.32	4596.52
	Miner's Inches	85.04	191 52	340.16	532.22	766.09	1360.64	2128.88	3064.36
	Revolutions..	1049	699	524	419	349	262	210	175
775	Horse Power..	161 83	364 46	647.34	1012.81	1457.85	2589.38	4051.26	5831.40
	Cubic Feet....	129 65	296.99	518.62	811.42	1167 97	2074.48	3245 68	4671.88
	Miner's Inches.	86.43	194 66	345.74	540.95	778.65	1382.96	2163.80	3114.60
	Revolutions..	1066	710	533	426	355	266	213	178
800	Horse Power..	169.66	382 09	678 66	1061.81	1528.36	2714 64	4247.24	6113.44
	Cubic Feet....	131 74	296 70	526.99	824.51	1186.81	2107.96	3298.04	4747.24
	Miner's Inches.	87.83	197.80	351.32	549.68	791.21	1405.28	2198.72	3164.84
	Revolutions..	1083	722	542	433	361	271	217	181
850	Horse Power..	186.05	419.01	744.24	1164.41	1676.06	2976.96	4657.66	6704.24
	Cubic Feet....	135.74	305.70	542.97	849.52	1222 81	2171.90	3398 08	4891.24
	Miner's Inches.	90.49	203.80	361.98	566 35	815 20	1447.92	2265.40	3260.82
	Revolutions...	1116	744	558	446	372	279	223	186
900	Horse Power..	202.45	455.94	809 82	1267 02	1823.76	3239 28	5068.08	7295.04
	Cubic Feet....	139.74	314.70	558.96	874 53	1258.81	2235.84	3498.12	5035.24
	Miner's Inches.	93.16	209 80	372.64	583.02	839.20	1490 56	2332.08	3356.80
	Revolutions...	1149	766	574	459	383	287	229	192
950	Horse Power..	219.78	494.97	879.15	1375 49	1979.90	3516 60	5501.98	7919.60
	Cubic Feet....	143.52	323.21	574.07	898 18	1292.86	2296 30	3592.72	5161.44
	Miner's Inches	95.68	215.47	382.71	598.79	861.90	1530.86	2395.16	3447.62
	Revolutions..	1179	786	589	471	393	295	235	197
1000	Horse Power..	237.12	534.01	948.48	1483.97	2136.04	3793.92	5935.88	8544.16
	Cubic Feet....	147.30	331.72	589.19	921.83	1326 91	2356.76	3687.32	5287.64
	Miner's Inches.	98.20	221.15	392.79	614.56	884.61	1571.16	2458 24	3538.44
	Revolutions..	1210	807	605	484	403	303	242	202

The above tables are based upon the following:

As to power on an efficiency of 85%.

As to cubic feet and miner's inches, on one miner's inch being equivalent to one and one-half cubic feet of water per minute.

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Price List of Risdon Standard Water Wheels.

Diam. Wheels.	HORSE POWER.														
	30	40	50	60	70	80	100	150	200	250	300	350	400	450	500
24″	$160	170	180	190	200	210	225	...	...	...	...	...	...	...	...
36″	170	180	190	200	210	220	250	275	300	...	...	...	...	...	...
48″	180	190	200	210	220	230	275	300	325	350	375	400	450	...	...
60″	200	210	220	230	240	250	300	325	350	375	400	450	500	...	...
72″	250	260	270	280	290	300	325	350	375	400	450	500	550	600	650
96″	350	360	370	380	390	400	425	450	475	500	550	600	650	700	750

All prices subject to change without notice.

The above will be found to be lower than any other price list of first-class water wheels manufactured.

The prices are for wheels complete, with buckets, shaft, boxes, collars, gate, gate flange to pipe, nozzle and three nozzle tips for change of power. Prices are for delivery at our works. We make a small extra charge for packing and cartage.

Prices for special wheels, or for special application, and also upon frames, either wood or iron, quoted on application.

Terms.

Cash on delivery at our works, or one-third cash with order; balance subject to sight draft with bill of lading.

Shipments.

Give full shipping directions with order. If any preference is had for any particular route, give name, etc.

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TABLES

—FOR—

Calculating the Horse-Power of Water.

MINERS' INCH TABLE

The following table gives the Horse-Power of one miner's inch of water under heads from one up to eleven hundred feet. This inch equals 1½ cubic feet per minute.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0024147	320	.772704
20	.0482294	330	.796851
30	.072441	340	.820998
40	.096588	350	.845145
50	.120735	360	.869292
60	.144882	370	.893439
70	.169029	380	.917586
80	.193176	390	.941733
90	.217323	400	.965880
100	.241470	410	.990027
110	.265617	420	1.014174
120	.289764	430	1.038321
130	.313911	440	1.062468
140	.338058	450	1.086615
150	.362205	460	1.110762
160	.386352	470	1.134909
170	.410499	480	1.159056
180	.434646	490	1.183206
190	.458793	500	1.207350
200	.482940	520	1.255644
210	.507087	540	1.303938
220	.531234	560	1.352232
230	.555381	580	1.400526
240	.579528	600	1.448820
250	.603675	650	1.569555
260	.627822	700	1.690290
270	.651969	750	1.811025
280	.676116	800	1.931760
290	.700263	900	2.173230
300	.724410	1000	2.414700
310	.748557	1100	2.656170

CUBIC FEET TABLE

The following table gives the Horse-Power of one cubic foot of water per minute under heads from one up to eleven hundred feet.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0016098	320	.515136
20	.032196	330	.531234
30	.048294	340	.547332
40	.064392	350	.563430
50	.080490	360	.579528
60	.096588	370	.595626
70	.112686	380	.611724
80	.128784	390	.627822
90	.144892	400	.643920
100	.160980	410	.660018
110	.177078	420	.676116
120	.193176	430	.692214
130	.209274	440	.708312
140	.225372	450	.724410
150	.241470	460	.740508
160	.257568	470	.756606
170	.273666	480	.772704
180	.289764	490	.788802
190	.305862	500	.804900
200	.321960	520	.837096
210	.338058	540	.869292
220	.354156	560	.901488
230	.370254	580	.933684
240	.386352	600	.965880
250	.402450	650	1.046370
260	.418548	700	1.126860
270	.434646	750	1.207350
280	.450744	800	1.287840
290	.466842	900	1.448820
300	.482940	1000	1.609800
310	.499038	1100	1.770780

When the Exact Head is Found in Above Table

EXAMPLE.—Have 100 foot head and 50 inches of water. How many Horse-Power?

By reference to above table the Horse-Power of 1 inch under 100 feet head is .241470. This amount multiplied by the number of inches, 50, will give 12.07 Horse-Power.

When Exact Head is Not Found in Table

Take the Horse-Power of 1 inch under 1 foot head and multiply by the number of inches, and then by number of feet head. The product will be the required Horse-Power.

NOTE.—The above formula will answer for the cubic feet table, by substituting the equivalents therein for those of miner's inches.

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"A Miner's Inch" of Water.

The term "miner's inch" is distinctively of California origin, having grown out of the method of measurement adopted by the various ditch companies in disposing of water to their customers.

A miner's inch of water varies in different localities to such an extent that it may almost be said to constitute an arbitrary quantity. Efforts have been made from time to time to make a miner's inch a fixed and uniform quantity of water. For various reasons this has failed, and we give below the measurements used by the principal ditch companies in California.

Measurement of Water by Different Ditch Companies in California.

DITCH COMPANIES.	Opening, Inches.	Pressure Board, Inches.	Mean Pressure, Inches.	Cubic Feet.
Amador Canal Co	2	4	5	1.40
Eureka Lake and Canal Co	2	5	6	1.45
Park Canal and Mining Co	2	5	6	1.45
Eldorado Water and Deep Gravel Mining Co.	4	4	6	1.45
Mok. and Campo Seco Canal and Mining Co.	4	3	5	1.40
Union Water Co., Murphy's	4	4	6	1.45
South Yuba Canal Co	4	4	6	1.45
North Bloomfield	2	6	7	1.60
Milton	2	6	7	1.60
La Grange	2	6	7	1.60
Smartsville Ditch Co	4	7	9	1.78

The North Bloomfield, Milton, and La Grange companies measure through a 3-inch plank; the others use 1 and 1½ inch planks.

For Usual Calculations.

A flow of one miner's inch of water is equal to the supply of:

	Gallons.	Cubic Feet.
Per second	.1875	025
Per minute	11.25	1.5
Per hour	675	90
Per day	16,200	2,160

Or a flow of one cubic foot

Per second equals 40 miner's inches.

Per minute equals $\frac{2}{3}$ miner's inches.

Per hour equals .01111+ miner's inches.

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TABLE SHOWING LOSS OF HEAD

—FOR—

EACH 100 FEET IN LENGTH OF DIFFERENT DIAMETERS OF PIPE

When Discharging the following quantities of Water per Minute.

INSIDE DIAMETER OF PIPE IN INCHES.

	1		2		3		4		5		6	
Velo- in ft. per sec.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
2.0	1.98	.65	.988	1.62	.659	5.89	.494	10.4	.395	16.3	.329	23.5
2.2	2.34	.73	1.170	2.88	.780	6.48	1.585	11.5	.468	18.	.390	25.9
2.4	2.73	.79	1.366	3.14	.911	7.07	.683	12.5	.547	19.6	.456	28.2
2.6	3.15	.86	1.576	3.40	1.05	7.65	.788	13.6	.631	21.3	.526	30.6
2.8	3.60	.92	1.800	3.66	1.20	8.24	.900	14.6	.720	22 9	.600	32 9
3.0	4.08	.99	2.04	3.92	1.35	8 83	1.02	15.7	.815	24.5	.679	35.3
3.2	4 56	1.06	2 28	4 18	1.52	9.42	1 14	16.7	.915	26.2	.763	37.7
3.4	5.08	1.13	2 54	4.45	1.70	10 00	1.27	17.8	1.02	27.8	.851	40.
3.6	5.64	1.19	2.82	4.71	1.89	10.60	1.41	18.8	1 13	29.4	.943	42.4
3.8	6.24	1.26	3.12	4.97	2.08	11 20	1.56	19.9	1 25	31.	1 04	44.7
4.0	6 84	1.32	3 42	5.23	2 28	11.80	1.71	20.9	1.37	32 7	1.14	47.1
4.2	7.48	1.39	3.74	5 49	2.49	12.30	1 87	22.0	1.50	34.3	1 25	49.5
4.4	8.12	1.45	4.06	5.76	2.71	12 90	2 03	23.0	1.63	36.0	1.35	51.8
4.6	8.84	1.52	4.42	6.02	2.94	13.50	2.21	24.0	1.76	37.6	1.47	54.1
4.8	9.52	1.58	4 76	6.28	3.18	14.10	2.38	25.1	1.91	39.2	1.59	56.5
5.0	10.28	1.65	5.14	6.54	3.43	14.70	2.57	26.2	2.05	40 9	1.71	58.9
5.2	11.04	1.72	5.52	6.80	3.68	15.30	2.76	27.2	2.21	42.5	1.84	61.2
5.4	11.84	1.78	5.92	7.06	3.94	15.90	2.96	28.2	2.37	44.2	1.97	63.6
5.6	12.64	1.85	6.32	7.32	4.22	16.50	3.16	29.3	2.53	45.8	2.11	65.9
5.8	13.48	1.91	6.74	7.58	4.50	17.10	3.37	30.3	2.70	47 4	2.25	68.3
6.0	14.36	1.98	7.18	7.85	4 78	17.70	3.59	31.4	2.87	49 1	2.39	70.7
7.0	19.08	2.31	9.54	9.16	6 35	20.6	4.77	36 6	3.81	57.2	3.18	82.4

INSIDE DIAMETER OF PIPE IN INCHES.

	7		8		9		10		11		12	
Velo lin ft. per sec.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
2.0	.282	32.0	.247	41.9	.220	53.	.198	65.4	.180	79.2	.165	94.2
2.2	.334	35.3	.293	46.1	.260	58.3	.234	72.	.213	87.1	.195	103.
2.4	.390	38.5	.342	50 2	.304	63.6	.273	78.5	.248	95.0	.228	113.
2.6	.450	41.7	.394	54.4	.350	68.9	.315	85.1	.287	103.	.263	122.
2.8	.514	44.9	.450	58 6	.400	74.2	.360	91.6	.327	111.	.300	132.
3.0	.582	48.1	.509	62 8	.453	70.5	.407	98.2	.370	119.	.339	141.
3.2	.654	51.3	.572	67	.508	84.8	.458	105.	.416	127.	.381	151.
3.4	.729	54.5	.638	71 2	.567	90 1	.510	111.	.464	134.	.425	160.
3.6	.808	57.7	.707	75.4	.629	95.4	.566	118.	.514	142.	.472	169.
3.8	.892	60.9	.780	79.6	.693	101.	.624	124.	.567	150.	.520	179.
4.0	.979	64.1	.855	83.7	.761	106.	.685	131.	.623	158.	.571	188.
4.2	1 07	67.3	.935	87.9	.832	111.	.748	137.	.680	166.	.624	198.
4.4	1.16	70.5	1.02	92.1	.905	116.	.814	144.	.740	174.	.679	207.
4.6	1.26	73.7	1.10	96 3	.981	122.	.883	150.	.803	182.	.736	217.
4.8	1 36	76 9	1.19	100.0	1 06	127.	.954	157.	.867	190.	.795	226.
5.0	1.47	80.2	1 28	105.	1 14	132.	1.03	163.	.935	198.	.857	235.
5.2	1.58	83 3	1.38	109.	1.23	138.	1.10	170.	1.00	206.	.920	245.
5 4	1 69	85 6	1.48	113.	1.31	143.	1.18	177.	1.07	214.	.986	254.
5.6	1.81	89.8	1.58	117.	1.40	148.	1.26	183.	1.15	222.	1.05	264.
5.8	1 93	93.0	1.68	121.	1.50	154.	1 35	190.	1.22	229.	1.12	273.
6.0	2 05	96.2	1.79	125.	1.59	159.	1.43	196.	1.30	237.	1.19	283.
7.0	2.72	122.0	2.38	146.	2 12	185.	1.90	229.	1.73	277.	1.59	330.

Add 20 per cent. to "Loss of Head" given above in calculations for Riveted Pipe.

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TABLE SHOWING LOSS OF HEAD

—FOR—

ACH 100 FEET IN LENGTH OF DIFFERENT DIAMETERS OF PIPE

When Discharging the following quantities of Water per Minute.

INSIDE DIAMETER OF PIPE IN INCHES.

lo ft. r c.	13		14		15		16		18		20	
	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
	.152	110	.141	128.	.132	147.	.123	167.	.110	212.	.099	262.
	.180	121.	.167	141.	.156	162.	.146	184.	.130	233.	.117	288.
	.210	133.	.195	154.	.182	176.	.171	201.	.152	254.	.137	314.
	.242	144.	.225	167.	.210	191.	.197	218.	.175	275.	.158	340.
	.277	156.	.257	179.	.240	2.6.	.225	234.	.200	297.	.180	366.
	.313	166.	.291	192.	.271	221.	.255	251.	.226	318.	.204	393.
	.352	177.	.327	205.	.305	235.	.286	268.	.254	339.	.229	419.
	.393	188.	.365	218.	.340	250.	.319	284.	.283	360.	.255	445.
	.435	199.	.404	231.	.377	265.	.354	301.	.314	382.	.283	471.
	.480	210.	.446	243.	.416	280.	.390	318.	.347	403.	.312	497.
	.527	221.	.489	256.	.457	294.	.428	335.	.380	424.	.342	523.
	.576	232.	.534	269.	.499	309.	.468	352.	.416	445.	.374	550.
	.626	243.	.582	282.	.543	324.	.509	368.	.452	466.	.407	576.
	.679	254.	.631	295.	.589	339.	.552	385.	.490	488.	.441	602.
	.734	265.	.682	308.	.636	353.	.596	402.	.530	500.	.477	628.
	.791	276.	.734	321.	.685	368.	.642	419.	.571	580.	.514	654.
	.850	287.	.789	333.	.736	383.	.690	435.	.614	551.	.552	680.
	.910	298.	.845	346.	.789	397.	.740	452.	.657	572.	.592	707.
	.973	309.	.903	359.	.843	412.	.791	469.	.703	594.	.632	733.
	1.04	321.	.964	372.	.899	427.	.843	486.	.749	615.	.674	759.
	1 10	332.	1.02	385.	.957	442.	.897	502.	.798	636.	.718	785.
	1.46	387.	1.36	449.	1.27	515.	1.19	586.	1.06	742.	.953	916.

INSIDE DIAMETER OF PIPE IN INCHES.

o ft. r c.	22		24		26		28		30		36	
	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
	.090	316.	.082	377.	.076	442.	.070	513.	.066	589.	.055	848.
	.106	348.	.097	414.	.090	486.	.083	564.	.078	648.	.065	933.
	.124	380.	.114	452.	.105	531.	.097	616.	.091	707.	.076	1018.
	.143	412.	.131	490.	.121	575.	.112	667.	.105	766.	.087	1100.
	.164	443.	.150	528.	.138	619.	.128	718.	.120	824.	.100	1188.
	185	475.	.170	565.	.157	663.	.145	770.	.136	883.	.113	1273.
	.208	507.	.191	603.	.176	708.	.163	821.	.152	942.	.127	1357.
	.232	538.	.213	641.	.196	752.	.182	872.	.170	1001.	.141	1442.
	.257	570.	.236	678.	.218	796.	.202	923.	.189	1060.	.157	1527.
	.284	601.	.260	716.	.240	840.	.223	974.	.208	1119.	.173	1612.
	.311	633.	.285	754.	.263	885.	.244	1026.	.228	1178.	.190	1697.
	.340	665.	.312	791.	.288	929.	.267	1077.	.249	1237.	.208	1782.
	.370	697.	.339	829.	.313	973.	.290	1129.	.271	1296	.226	1866.
	.401	728.	.368	867.	.339	1017.	.315	1180.	.294	1355.	.245	1951.
	.434	760.	.397	905.	.367	1062.	.341	1231.	.318	1414.	.265	2036.
	.467	792	.428	942.	.395	1106.	.367	1283.	.343	1472.	.285	2121.
	.502	823.	.460	980.	.425	1150.	.394	1334.	.368	1531.	.307	2206.
	.538	855.	.493	1018.	.455	1194.	.423	1385.	.394	1590.	.328	2291.
	.575	887.	.527	1055.	.486	1239.	.452	1437.	.422	1640.	.351	2376.
	.613	918.	.562	1093.	.519	1283.	.482	1488.	.450	1708.	.375	2460.
	.652	950.	.598	1131.	.552	1327.	.513	1539.	.478	1767.	.399	2545.
	.867	1109.	.794	1319.	.733	1548.	.681	1796.	.635	2061	.530	2868.

Add 20 per cent. to "Loss of Head" given above in calculations for Riveted Pipe.

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TABLE

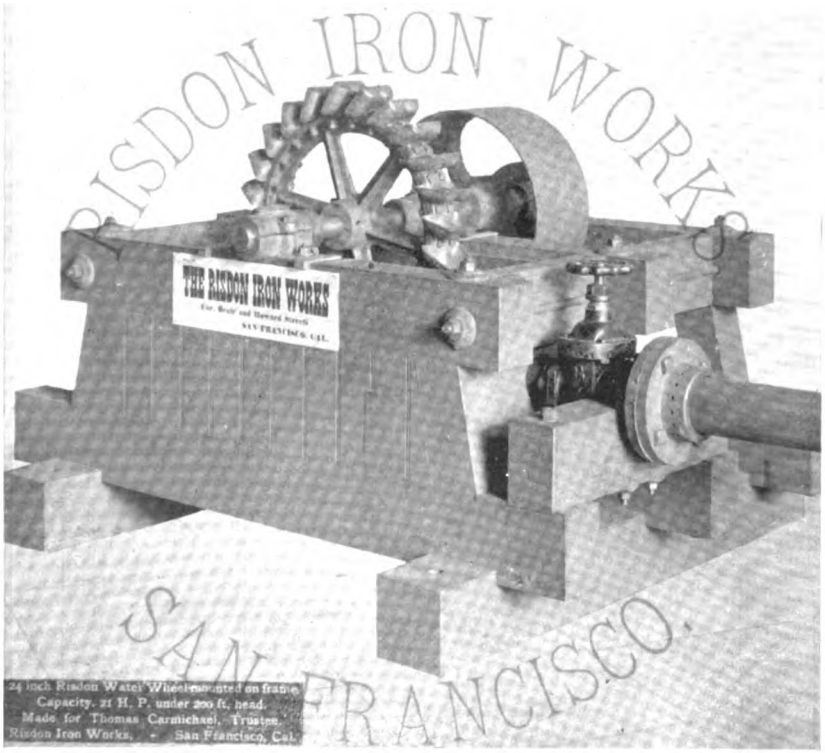
—OF—

SHEET IRON HYDRAULIC PIPE.

Diameter of Pipe in Inches.	Area of Pipe in Inches.	Thickness of Iron (Wire Gauge).	Head in Feet Pipe will Stand with Safety.	Cubic Feet of Water Pipe will Convey per Min. 3 Feet Velocity per Second.	Weight per Foot in Lbs.	Price per Foot.
3	7	18	400	9	2	20
4	12	18	350	16	2¼	25
4	12	16	525	16	3	35
5	20	18	325	25	3½	35
5	20	16	500	25	4¼	45
5	2	14	675	25	5	50
6	28	18	296	36	4¼	45
6	28	16	487	36	5¼	50
6	28	14	743	36	7½	55
7	38	18	254	50	5¼	50
7	38	16	419	50	6¾	55
7	38	14	640	50	8½	65
8	50	16	367	63	7½	65
8	50	14	560	63	9½	75
8	50	12	854	63	13	95
9	63	16	327	80	8½	70
9	63	14	499	80	10¾	85
9	63	12	761	80	14¼	1 05
10	78	16	295	100	9¾	70
10	78	14	450	100	11¾	85
10	78	12	687	100	15¾	1 00
10	78	11	754	100	17½	1 25
10	78	10	000	100	19¼	1 50
11	95	16	269	120	9¾	75
11	95	14	412	120	13	95
11	95	12	626	120	17¼	1 25
11	95	11	687	120	18¾	1 45
11	95	10	820	120	21	1 60
12	113	16	246	142	11¼	85
12	113	14	677	142	14	1 00
12	113	12	374	142	18½	1 40
12	113	11	630	142	19¾	1 50
12	113	10	753	142	22¾	1 70
13	132	16	228	170	12	90
13	132	14	348	170	15	1 10
13	132	12	530	170	20	1 50
13	132	11	583	170	22	1 65
13	132	10	696	170	24½	1 80
14	153	16	211	200	13	1 00
14	153	14	324	200	16	1 15
14	153	12	494	200	21½	1 55
14	153	11	543	200	23½	1 70
14	153	10	648	200	26	1 95
15	176	16	197	225	14	1 00
15	176	14	302	225	17	1 25
15	176	12	460	225	23	1 75
15	176	11	507	225	24½	1 95
15	176	10	606	225	28	2 10
16	201	16	185	255	14½	1 05
16	201	14	283	255	17¼	1 25
16	201	12	432	255	24¼	1 75
16	201	11	474	255	26½	1 95
16	201	10	567	255	29½	2 15
18	254	16	165	320	16½	1 20
18	254	14	252	320	20½	1 40
18	254	12	385	320	27¼	1 90
18	254	11	424	320	30	2 10
18	254	10	505	320	34	2 40
20	314	16	148	400	18	1 25
20	314	14	227	400	22½	1 55
20	314	12	348	400	30	2 10
20	314	11	380	400	32½	2 25
20	314	10	456	400	36½	2 50
22	380	16	135	480	20	1 40
22	380	14	206	480	24¾	1 70
22	380	12	316	480	32¾	2 25
22	380	11	347	480	35¾	2 45
22	380	10	415	480	40	2 80
24	452	14	188	570	27	1 90
24	452	12	290	570	36	2 50
24	452	11	318	570	39	2 85
24	452	10	379	570	44	3 10
24	452	8	466	570	53	3 70
26	530	14	175	670	30	2 10
26	530	12	267	670	39	2 75
26	530	11	294	670	42	3 00
26	530	10	352	670	47	3 30
26	530	8	432	670	58	4 10
28	615	14	162	775	32	2 25
28	615	12	247	775	42	2 00
28	615	11	273	775	45	3 15
28	615	10	327	775	51	3 40
28	615	8	400	775	62	4 35
30	706	12	231	890	44	3 10
30	706	11	254	890	48	3 35
30	706	10	304	890	54	3 80
30	706	8	375	890	65	4 55
30	706	7	425	890	74	5 20
36	1017	11	141	1300	58	4 10
36	1017	10	155	1300	67	4 70
36	1017	8	192	1300	78	5 50
36	1017	7	210	1300	88	6 15
40	1256	10	141	1600	71	5 00
40	1256	8	174	1600	86	6 00
40	1256	7	189	1600	97	6 80
40	1256	6	213	1600	108	7 60
40	1256	4	250	1600	126	8 80
42	1385	10	135	1760	75	5 25
42	1385	8	165	1760	91	6 40
42	1385	7	180	1760	102	7 15
42	1385	6	210	1760	114	8 00
42	1385	4	240	1760	133	9 30
42	1385	¼	270	1760	137	9 60
42	1385	3/16	300	1760	145	10 15
42	1385	5/32	321	1760	177	12 40
42	1385	⅛	363	1760	216	15 15

NOTE.—The prices quoted here are to assist intending purchasers to make an approximate estimate of cost. Net prices will be quoted on application.

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The above illustration of is one of our wheels set up on a wood frame, which is for shipment to localities where proper lumber is not to be had, or where it may not be convenient to make such a frame-work. In such cases the whole frame is properly framed, all the iron work fitted to place, the whole thing properly and clearly marked, then taken apart and packed or crated for shipment.

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In many cases we can supply our customers with these wooden frames at considerably cheaper cost than they can be made for on the ground. Where freights are not excessive, it would be economy to purchase the frame from us. This would afford the purchaser the advantage of having the nozzle and gate properly set to place.

Pipe Lines.

We manufacture all sizes of riveted water pipe, and have the largest plant for its manufacture in the United States, having built most of the heaviest pipe lines of this character in use in this country. Our facilities and experience enable us to give our customer the pipe line that will answer all his requirements.

Pulleys, Shafting, Boxes,

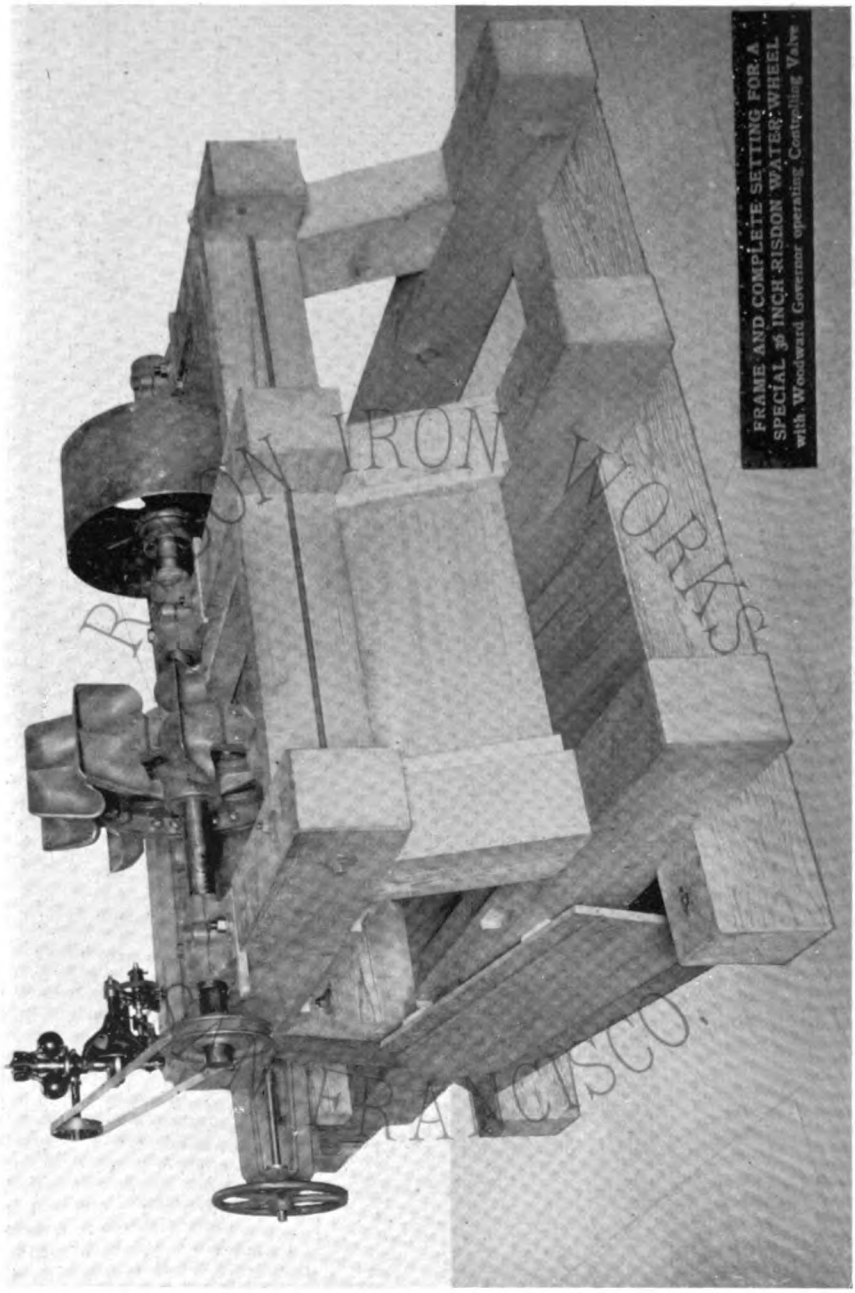
and all parts pertaining to power transmission, furnished at the most reasonable prices.

Information

of a more definite character beyond the limits of this book we shall at all times cheerfully furnish, and invite correspondence in relation thereto.

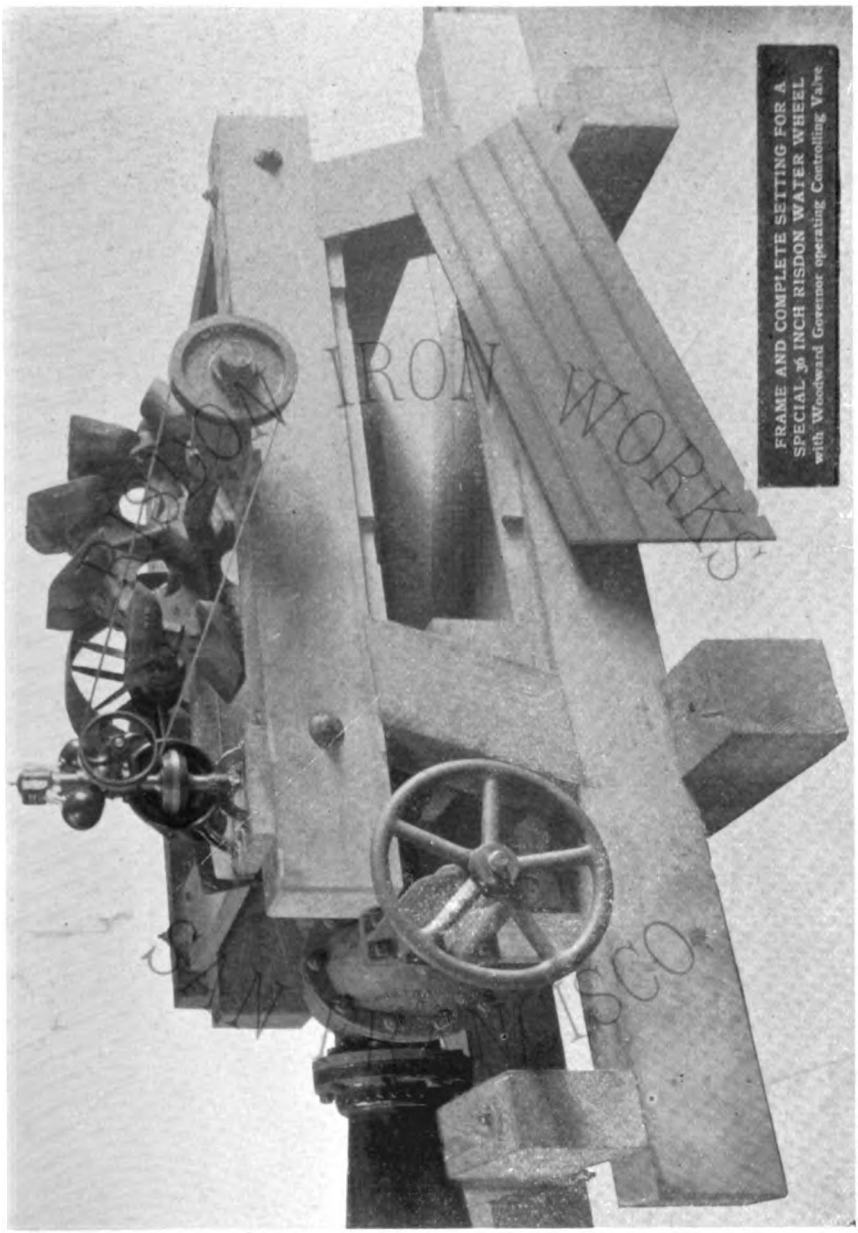
Net prices will be quoted on application.

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On these pages we illustrate two views of a special wheel mounted on wood frame. It was made for a special case, to develop a comparatively large power under a low head, and to have a much faster speed than could have been had with a standard wheel. It is shown fitted with a Woodward Differential Governor, which operates a butterfly valve, placed between the gate and the nozzle.

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This insures a close regulation; close enough for ordinary mill running and forms a simple and effective arrangement where extremely fine regulation is not needed.

These illustrations indicate the flexibility of wheel construction, enabling us to suit any condition or requirement.

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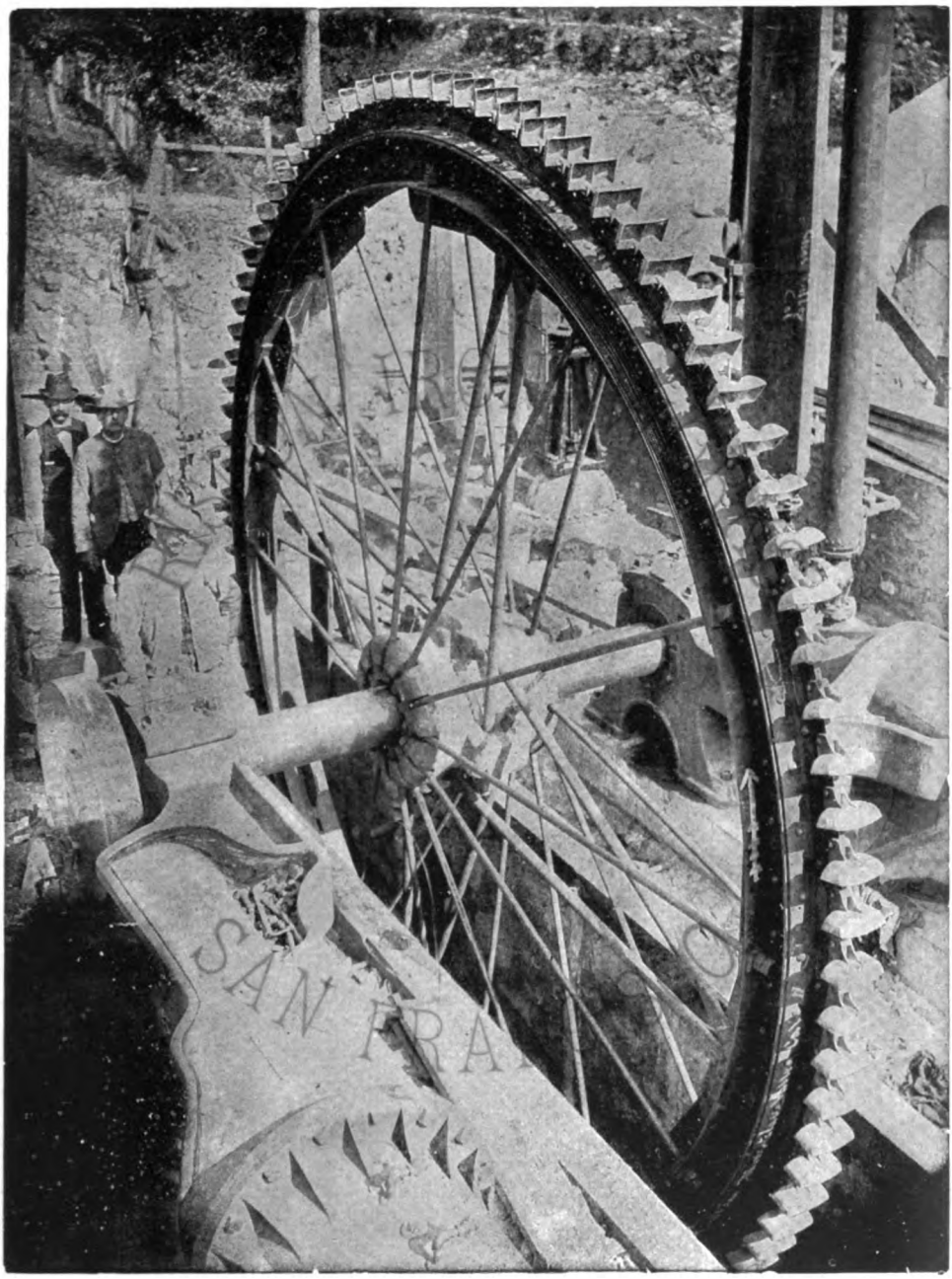


We herewith illustrate Risdon Water Wheel used as a prime mover and fly-wheel for driving a water power compressor.

We also illustrate on the inside of back cover this wheel in place. As shown in the title, the wheel runs under a head of 400 feet, and develops 500 horse power. The compressed air is transmitted 7,500 feet from the compressor to the mine, where it is reheated and utilized for hoisting and pumping, also for driving rock drills. This is a very important installation, and one in which we take pleasure in calling attention to miners who require power transmitted to the mines at a point above where their water power is effective.

We will furnish data for intending purchasers covering the transmission of power by compressed air.

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Where desired, we build large water wheels, with wrought iron rim and spokes; as illustrated herewith. This special construction was patented August 4th, 1896.

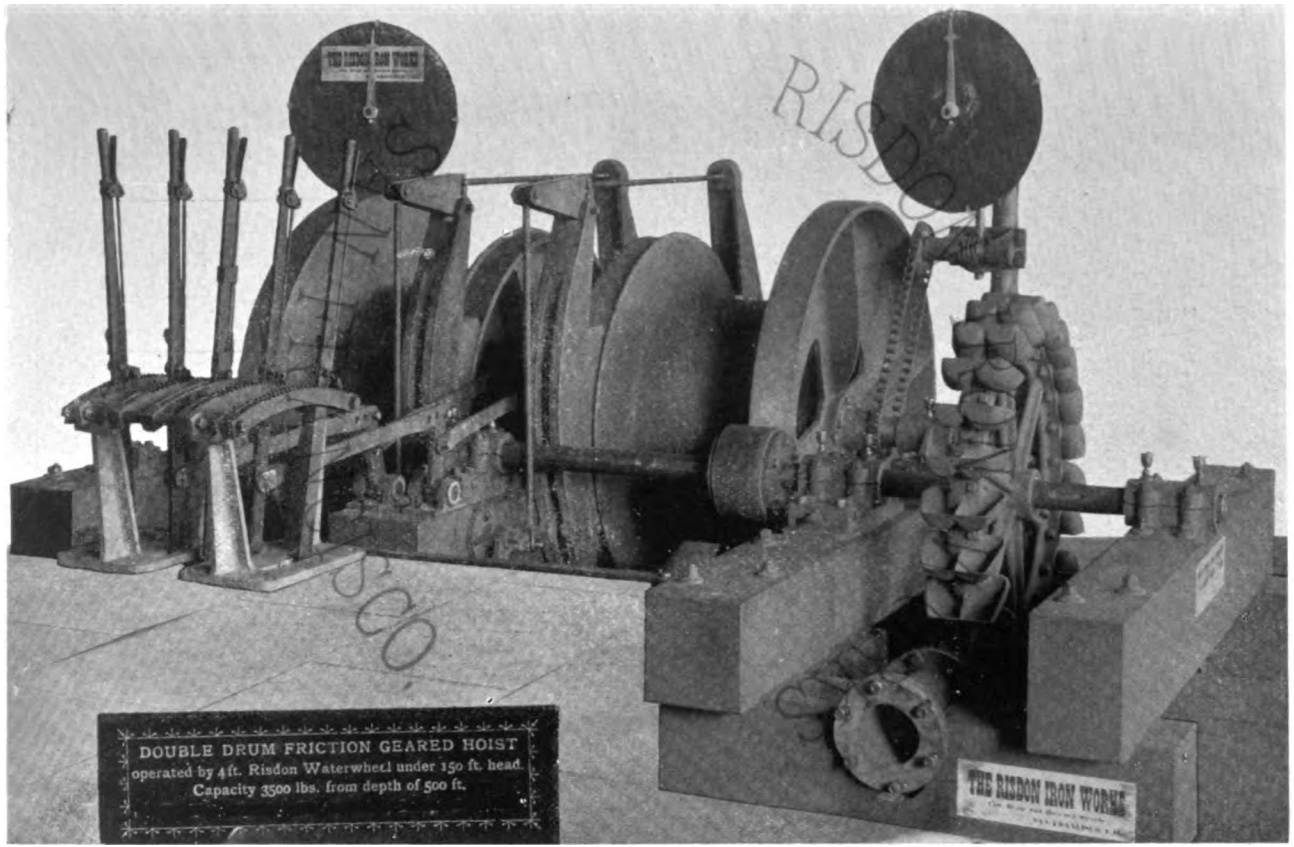
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We illustrate herewith one of our water power hoists, which style is largely in use throughout the mining camps of this country, and is a reliable, steady running machine, which we strongly recommend to any one having water power and using hoisting apparatus. The nozzle is controlled by a set of levers running within easy reach of the operator. It is generally intended in most hoisting works to lower the cage with the brake, but in some cases we have placed an additional wheel reversed on shaft, for lowering by power, or for using cages to balance each other. We build any size that may be required, but below is a list of a few of our standard sizes, with approximate weights and prices:

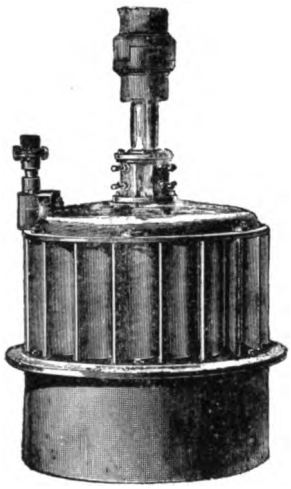
Diameter of Drum. Feet.	Diameter of Friction Wheel. Feet.	Diameter of Water Wheels.	WEIGHT Lbs.	Price of Single Drum Machine.	Price of Double Drum Machine.	Additional Price for Reversible Wheel.
3	3	36″	5,000	$ 750	$ 850	$200
4	5	48″	10,000	1100	1400	250
5	6	60″	12,000	1200	1500	350
7	8	72″	24,000	2000	2500	500

We can build the above sizes either with single or double drums for round rope, or single or double reels for flat rope, and make each drum independent by means of a positive clutch or by using paper frictions, as shown.

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THE "REGISTER GATE" VICTOR TURBINE.
(Patented Oct. 2, 1877.)

THE Victor Turbine IS THE Best in the World.

Possesses more than double the capacity of other water wheels of same diameter and has produced the best series of results on record in Holyoke Testing Flume, as will appear in the tests reported in our circular, which is furnished on application.

In construction it is compact, simple and strong, and is provided with a perfect gate that operates easily under any head.

RISDON IRON WORKS SAN FRANCISCO

SCIENTIFIC TESTS

EXAMINE THE RECORD MADE BY THE

"Register Gate" Victor Turbine

In the Testing Flume at Holyoke, Mass., and reported below

Various sizes of the "REGISTER GATE VICTOR TURBINE" have been subjected to a series of tests in the Holyoke Testing Flume, by competent and disinterested engineers, for the purpose of correctly determining its power and efficiency, and the results developed as published herewith, are the BEST ON RECORD. This testing flume is provided with all the most improved appliances for making such tests, and is open to all on the same terms. All of the wheels of any considerable reputation have been tested, and the results produced are on record, so that parties desiring to investigate the actual efficiency of the respective Turbines can do so.

	Head in Feet.	Revolutions per Minute.	Horse Power.	Cubic Feet of Water per Min.	Percentage Useful Effect.
15-inch wheel	18 08	368	30 17	90 19	.8932
	18 08	356	30 12	996 83	.8849
17½-inch wheel	18 02	280	36 51	1164 60	.8960
	17 96	292	36 31	1197	.8950
	17 96	284 6	35 64	1202 4	.8790
20-inch wheel	18 22	266	46 75	1660 17	.8532
	18 23	275	48 75	1660 17	.8628
	18 21	269 5	49	1671 57	.8522
25-inch wheel	17 79	205 5	67 72	2362 72	.8630
	17 96	209	68 62	2336 54	.8584
	17 80	212 5	67 61	2 56	.8573
30-inch wheel	11 65	144 5	52 64	2751 87	.8676
	11 66	147 5	51 96	2750 09	.8564
	11 70	142	52 02	27 8	.8614
35-inch wheel	17 51	151 7	135 68	4895	.8489
	17 20	16	133 19	4806	.8497
	17 32	147	136 08	4 05	.8491
40-inch wheel	16 49	130	118 93	6789	.8253
	16 47	124	144 88	5816	.82 1
44-inch wheel	15 54	116 50	155 47	6581	.8037
	15 50	109 25	135 78	6043	.8003
48-inch wheel	15 51	102	179 49	7456	.8202

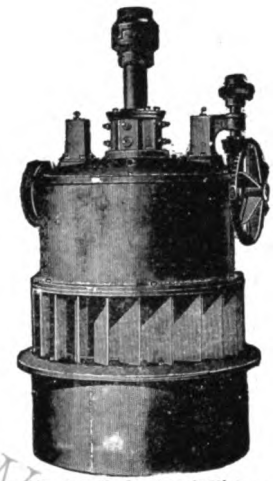
In order to be able to meet all demands of water power application, in low heads, as well as in high, we offer the celebrated Victor Turbines to supply such demand,

Upon application, giving particulars called for on page 3, we will give full information, prices, etc.

CORRESPONDENCE INVITED.

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POWER OF THE VICTOR



The "Cylinder Gate" Victor Turbine.

We invite particular attention to the EXTRAORDINARY POWER developed by the Victor Wheel in proportion to its diameter, being from two to three times greater than that of other turbines hitherto regarded as first class wheels—a fact so startling as to be almost incredible at first to many of our correspondents. This feature is of great practical importance in the application of a wheel to the propulsion of machinery, as it carries with it numerous advantages among which we may name economy of space, quick speed (a matter of special importance under *low falls*) light gearing, less wear and tear, and loss in transmitting power. It also secures greater accuracy of construction, with better finish and proportional strength of each part.

This feature of great capacity in a small diameter of wheel particularly adapts the Victor for shipment over long and expensive routes, as its weight per horse power is much less than wheels of ordinary construction.

We claim that in the construction of the Victor we have reduced the various parts of a portable wheel and case to the smallest number compatible with the greatest efficiency.

Every separate piece of our wheel and case is fitted up to a standard gauge with the greatest care—the labor being performed with the most improved machinery.

We invite the most careful comparison of our Victor Wheel in all respects with any and all other turbines in the market; and without wishing to boast, we challenge competition from any source, in respect to POWER, SIMPLICITY, DURABILITY, STRENGTH AND ACCESSIBILITY OF ALL ITS PARTS.

Results of Tests of the

"Cylinder Gate" Victor Turbine.

MADE IN THE TESTING FLUME OF THE HOLYOKE WATER POWER CO., HOLYOKE, MASS.

Size of Wheel.	Head in Feet.	Revolutions of Wheel per Minute.	Cubic Feet Water per Min.	Horse Power Developed by Wheel.	Per entage Useful Effect.
30-inch Full Gate	17.51	168	4410	119.56	81.35
⅞ "	17.82	163	3892	104.93	80.03
¾ "	1 .95	163	3592	88.24	76.66
⅝ "	18 10	155	2893	7 97	71.28
½ "	18. 0	159	2265	51.42	63 46
36-inch Full Gat	16.78	135	6106	158.18	81.80
⅞ "	17.14	135	5422	141.58	80 71
¾ "	17.35	1 0	4708	118.22	76.68
⅝ "	17.05	1 9	3982	91 62	71.50
½ "	17.48	134	3202	66.87	63.30
39-inch Full Gate	14 66	116	873	152.66	80.37
⅞ "	14.52	118	5920	129.41	79.80
¾ "	16.84	125	5517	135 56	77,40
⅝ "	17.06	123	4695	108.'2	71.67
½ "	17.39	124	3856	8'.00	64.07
48-inch Full Gate	13.23	91	10072	201.71	80 11
⅞ "	14.36	89	9042	192-41	78,42
¾ "	14.75	89	7869	165.23	75.34
⅝ "	14.87	85	6744	132.76	70.06
½ "	15.28	87	55 6	100.66	63.09

NOTE.—In the above calculations "fractional gate" means "fractional water," regardless of the position of the gate of the turbine; that is, "three quarters gate" means that the gate is closed to a point where the discharge of water is only theee-fourths of what it is at full gate *under the same head*.

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Price List of "Register Gate" Victor Turbines

Of Standard Pattern and Weight, page 34

In selecting a Turbine, price should not be considered alone, but HIGH EFFICIENCY, SUPERIORITY OF CONSTRUCTION, SIMPLICITY and a PERFECT GATE should be estimated at a fair value. From and after this date the following prices will be in force, but are subject to change without notice:

6-inch	wheel	made	of	Brass	Price	$ 200
8	"	"	"	"	"	215
10	"	"	"	"	"	225
12	"	"	"	Iron and Brass	"	240
15	"	"	"	"	"	250
17½	"	"	"	"	"	290
20	"	"	"	"	"	325
22½	"	"	"	"	"	400
25	"	"	"	"	"	435
27½	"	"	"	"	"	500
30	"	"	"	"	"	550
32½	"	"	"	"	"	650
35	"	"	"	"	"	700
40	"	"	"	"	"	875
44	"	"	"	"	"	1100
48	"	"	"	"	"	1300
55	"	"	"	"	"	20 0
60	"	"	"	"	"	2500

RIGHT IRON TURBINES

PRICE-LIST OF

"Cylinder Gate" Victor Turbines

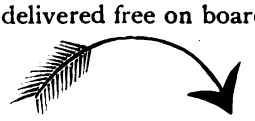
OF STANDARD PATTERN AND WEIGHT

As Illustrated on Page 35

Size of Wheel.	List Price.	Sq. in of water used.	Approximate Weight.
15 inch	$ 275.00	78	1070 lbs.
18 "	325.00	109	1650 "
21 "	375.00	153	2525 "
24 "	450.00	189	3250 "
27 "	525.00	252	4225 "
30 "	600.00	298	5325 "
33 "	700.00	377	630 "
36 "	825.00	426	7750 "
39 "	975.00	524	8775 "
42 "	1150.00	624	11250 "
45 "	1350.00	701	12550 "
48 "	1600.00	773	14225 "
51 "	1900.00	873	21000 "
54 "	2250.00	1009	22475 "
57 "	quoted on application	1090	
60 "	" " "	1208	

In comparing above prices with prices of other Wheels, compare also the Power of the respective Wheels and compute the relative cost per Horse Power.

The above Price List is for wheels complete as shown on pages 34 and 35 delivered free on board cars at Dayton, Ohio.



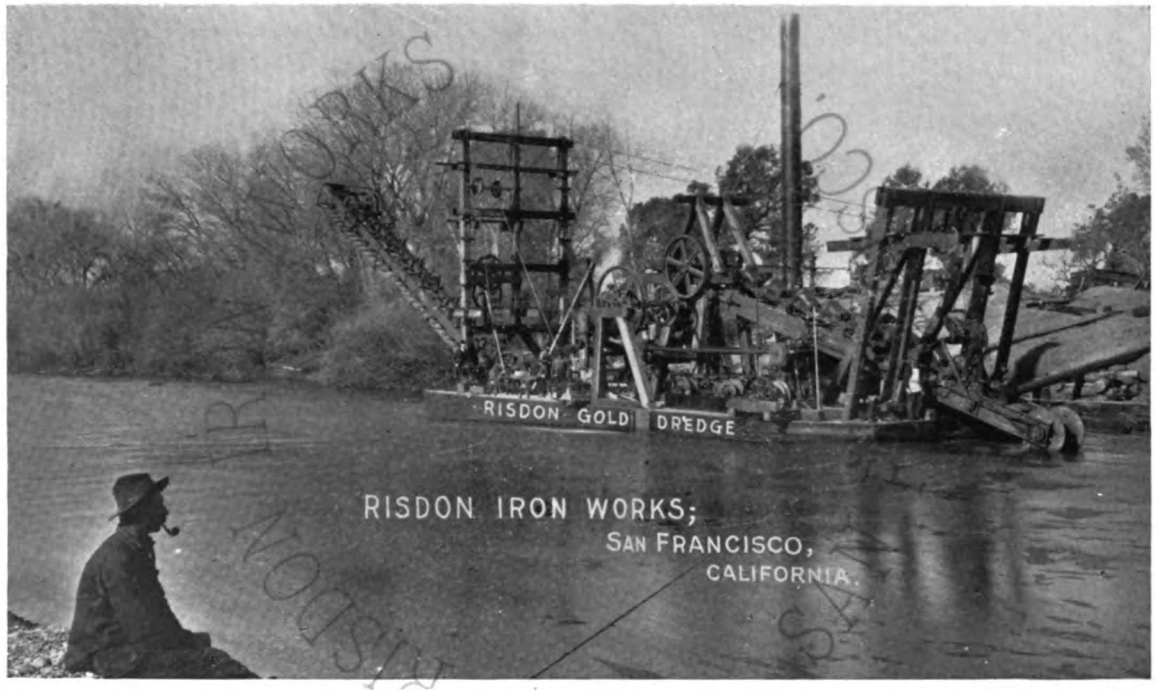
With the Sun, or Right Hand.

In ordering wheels, state whether they are to *run with the sun*, or *against the sun*.



Against the Sun, or Left Hand.

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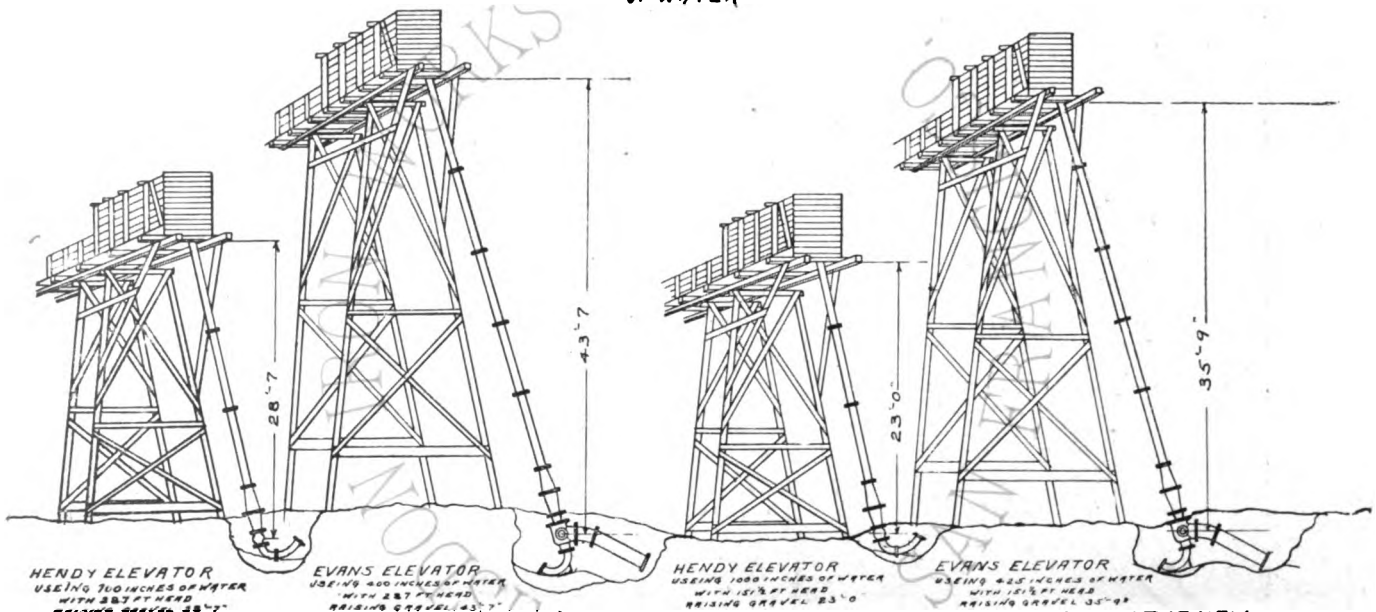


GOLD DREDGING IN CALIFORNIA

Capacity 2,000 cubic yards per day, at a cost of 3 cents per cubic yards

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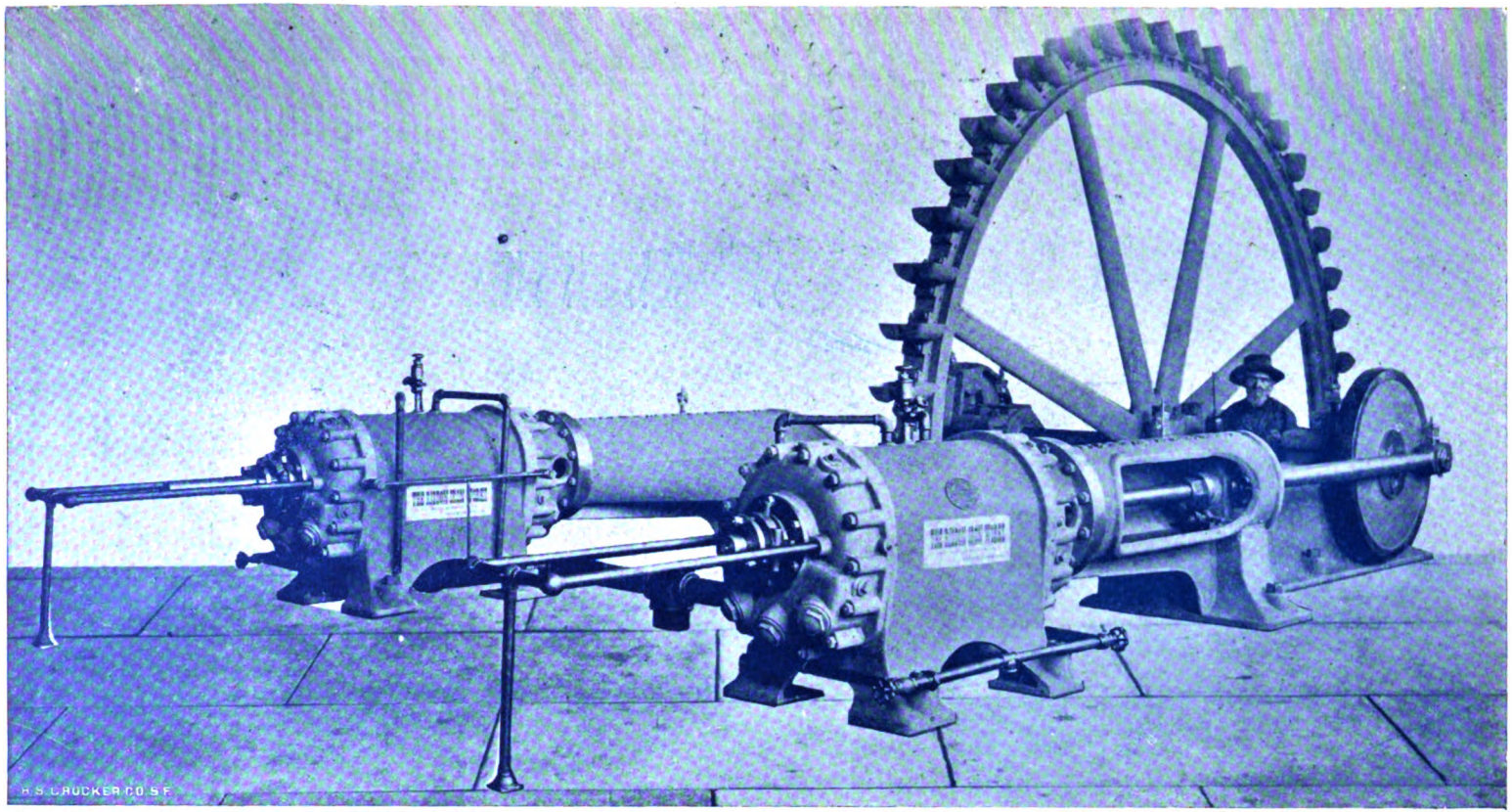
REPLACING HENDY ELEVATORS WITH THE EVANS SYSTEM BY
RISDON IRON WORKS S.F. CAL.
AT ORO FINO MINE LIFTING 25% MORE GRAVEL OVER 50% HIGHER WITH HALF THE QUANTITY OF WATER



HENDY ELEVATORS WERE REPLACED BY EVANS ELEVATORS MARCH 18, 1898. AND THE VIEW SHOWS HOW THE NEW ELEVATORS RAISED 25% MORE GRAVEL WITH ABOUT ONE HALF THE QUANTITY OF WATER
THIS SKETCH IS MADE FROM ACTUAL PHOTOGRAPHS SHOWING THE HENDY ELEVATORS IN POSITION ANYONE INTERESTED IN GRAVEL MINING CAN SEE AT THIS MINE BOTH MACHINES SETTING SIDE BY SIDE SHOWING HOW THE HENDY MACHINE HAS BEEN SUPERSEDED BY THE EVANS BOTH IN QUANTITY OF MATERIAL, HEIGHT LIFTED, AND QUANTITY OF WATER USED

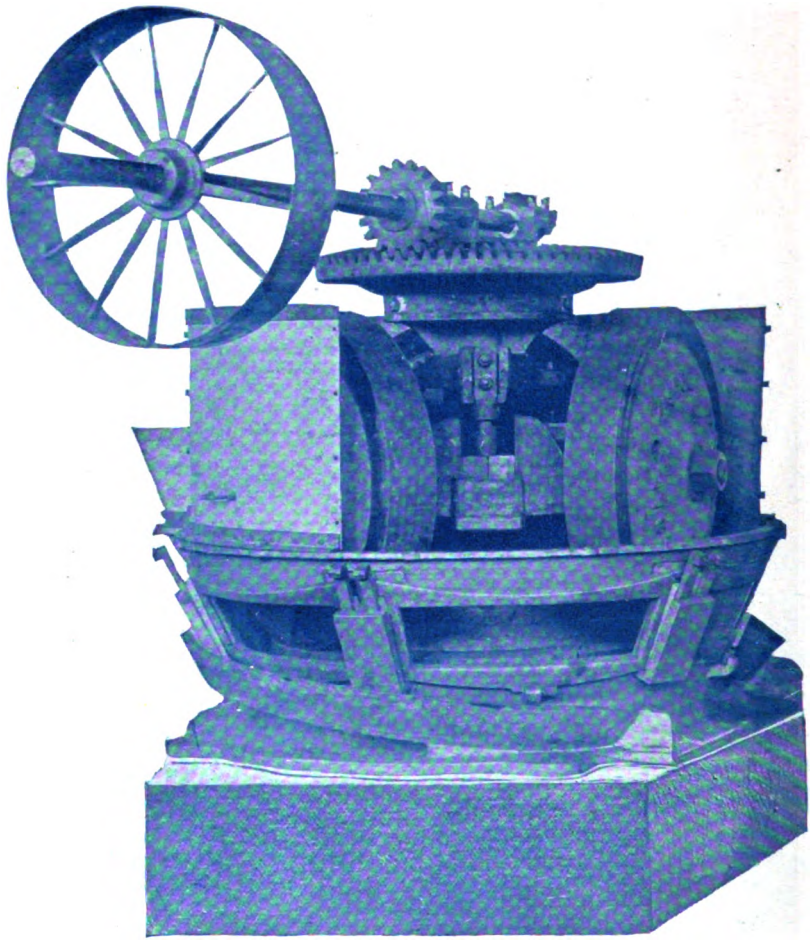
SEND FOR CATALOGUE No. 5 ON EVANS ELEVATOR.

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500 Horse Power Risdon Inlet Air Compressor, driven direct by Risdon Water Wheel, 24 ft. diameter.

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Bryan Roller Quartz Mill

ADAPTED TO THE

Milling and Reduction of Gold and Silver Ores

Send for Bryan Mill Catalogue

DONE IN SAN FRANCISCO AT PRINTING SHOP OF THE E. D. TAYLOR COMPANY WHICH IS AT No 23 STEVENSON STREET.

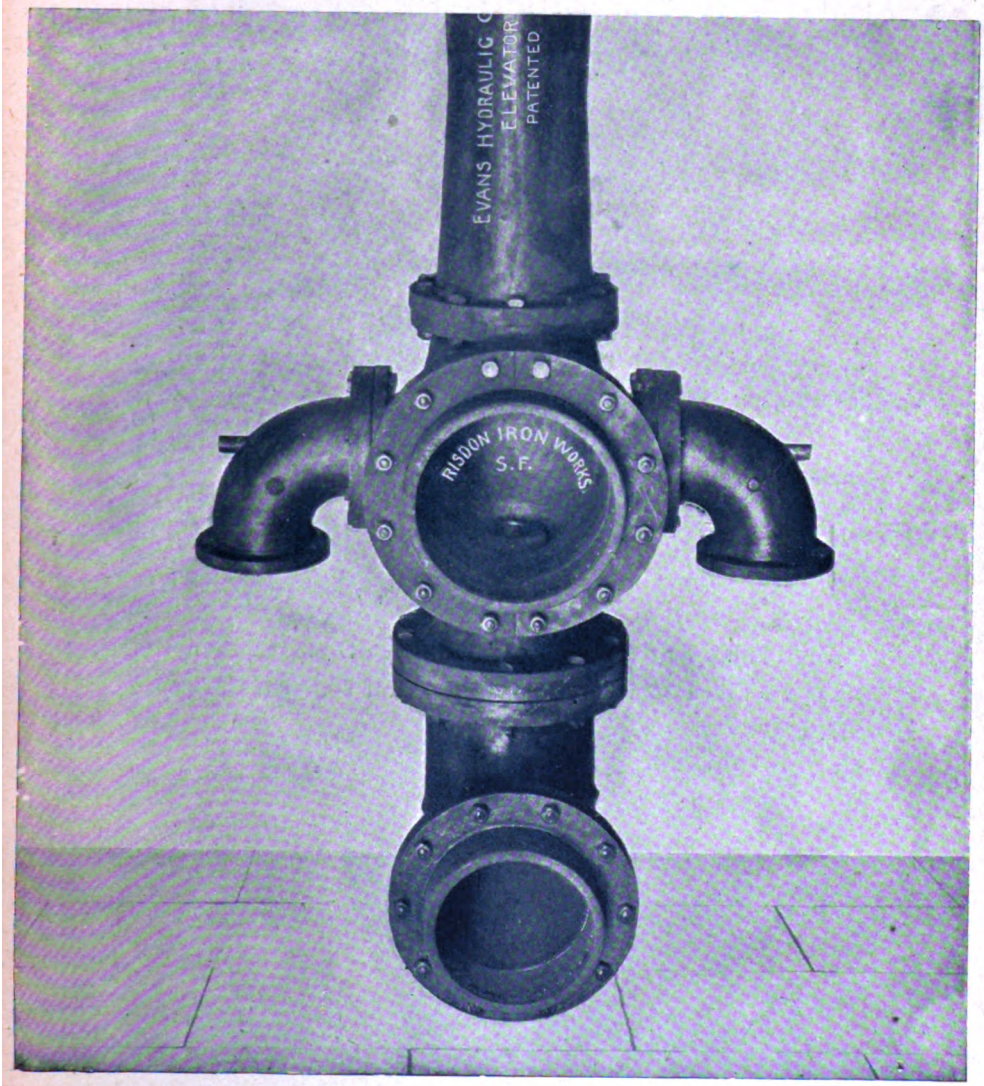
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CATALOGUE NO. 5

Evans Hydraulic Elevator

AND

Hydraulic Mining Machinery



PUBLISHED BY

THE RISDON IRON WORKS

SAN FRANCISCO, CAL.

1897

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Terms, Shipments, etc.

TERMS:

Cash on delivery at our works, or one-third cash with order; balance subject to sight draft with bill of lading.

SHIPMENTS.

Give full shipping directions with order. State whether preference is to be given to a certain route, and, if so, give the name of railroad, etc.

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PRESS OF
H. S CROCKER COMPANY
SAN FRANCISCO

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PREFACE.

* * *

This catalogue, devoted to Evans Elevator and Hydraulic Mining Machinery, we call "No. 5," and we trust that it will be of interest to placer and river-bed miners.

Hydraulic mining, which has been suspended for a number of years, is now under United States Government control. With the reopening, and a renewal of this class of mining, the demand for new and improved machinery is increasing. We place the Evans System of Elevators on the market after a thorough investigation, and can promise our patrons an article superior to any other.

Our giants, deflectors, pipes, riffles, undercurrents and gold-saving tables are all of the latest pattern; and from reports from all parts of the world we know they are doing good work.

Our facilities are equal to any in this country. We are the largest manufacturers of riveted pipe in the world.

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Evans Gravel Elevator.

We illustrate in plates 1 and 2 two views of the Evans Hydraulic Elevator, a late invention which has already revolutionized hydraulic and river-bed mining. The principal features of the elevator are the three suctions, one main and two auxiliary,—the two auxiliary allowing the water and material to enter at the back of the seat, thus reducing the wear and tear on the machine. The auxiliary opening also increases the efficiency of the elevator by allowing the proper proportion of air to enter with the water and material even when the main suction opening is choked.

The auxiliary-suction openings can be extended with any size pipe to any distance beyond the elevator proper, and be used for draining places in the bedrock below the line of the sluices connecting with the elevator. This is a great advantage, and can be carried on without interfering with the sluicing of material to the main opening in the elevator seat. This elevator will show from twenty to thirty per cent greater efficiency than any other elevator heretofore used. This has been conclusively proved by the operations at the Golden Feather Channel, where a number of these elevators are being used this year in place of the old style which were used heretofore.

Another strong point in favor of the Evans Elevator is that it is not necessary to sink a shaft to bedrock to place the machine in position to work. They are easily manipulated, and so light that they will sink their own pits, thereby avoiding not only a loss of time, but the great expense of sinking and pumping in wet ground. The usual way of setting these elevators is to fit them together on the bank and lower them into position, two men doing all the work necessary.

All the joints on the elevators are made with revolving flanges, which (with taper rings) will make any adjustment necessary for rapid connection.

In placing one of the sixteen-inch elevators at the Golden Feather this year, —in twelve hours it was fitted up, lowered to the bottom of the river and working, throwing eighteen million gallons per twenty-four hours. All the excavating necessary to be done was a space of four square feet as against one of the old-style elevators placed last year, in which it was necessary to have divers place the elevator in position as well as excavate a space of 128 square feet. There is no necessity to use water elevators in connection with this system of elevating, as one of the auxiliary suctions will take care of all the water in the pit.

The only difference between the cast iron and steel elevators is the difference in weight, making the steel elevator more easily handled and capable of being made in sections weighing not more than 290 pounds, suitable for mule transportation. The heaviest elevator of this style will weigh less than one-third that of the old-style machines.

We show several illustrations of these elevators in position on the Golden Feather, where they elevate gravel fifteen feet for each one hundred feet of pressure. In two cases they have elevated fifty-two feet with 250 feet pressure, and, with a 2¾-inch jet, elevated all the water from a 2½-inch giant with the same head, together with all the gravel and sand it was possible to pipe down the sluice with a grade of three inches to twelve feet. In the last instance only four hundred inches of water were used for both elevator and giant, and 2,400 tons of material were elevated daily—elevator casting iron not renewed for three years. At the Golden Feather, the elevators are working in the river bed with most satisfactory results, and have conclusively proved their great superiority over those previously used.

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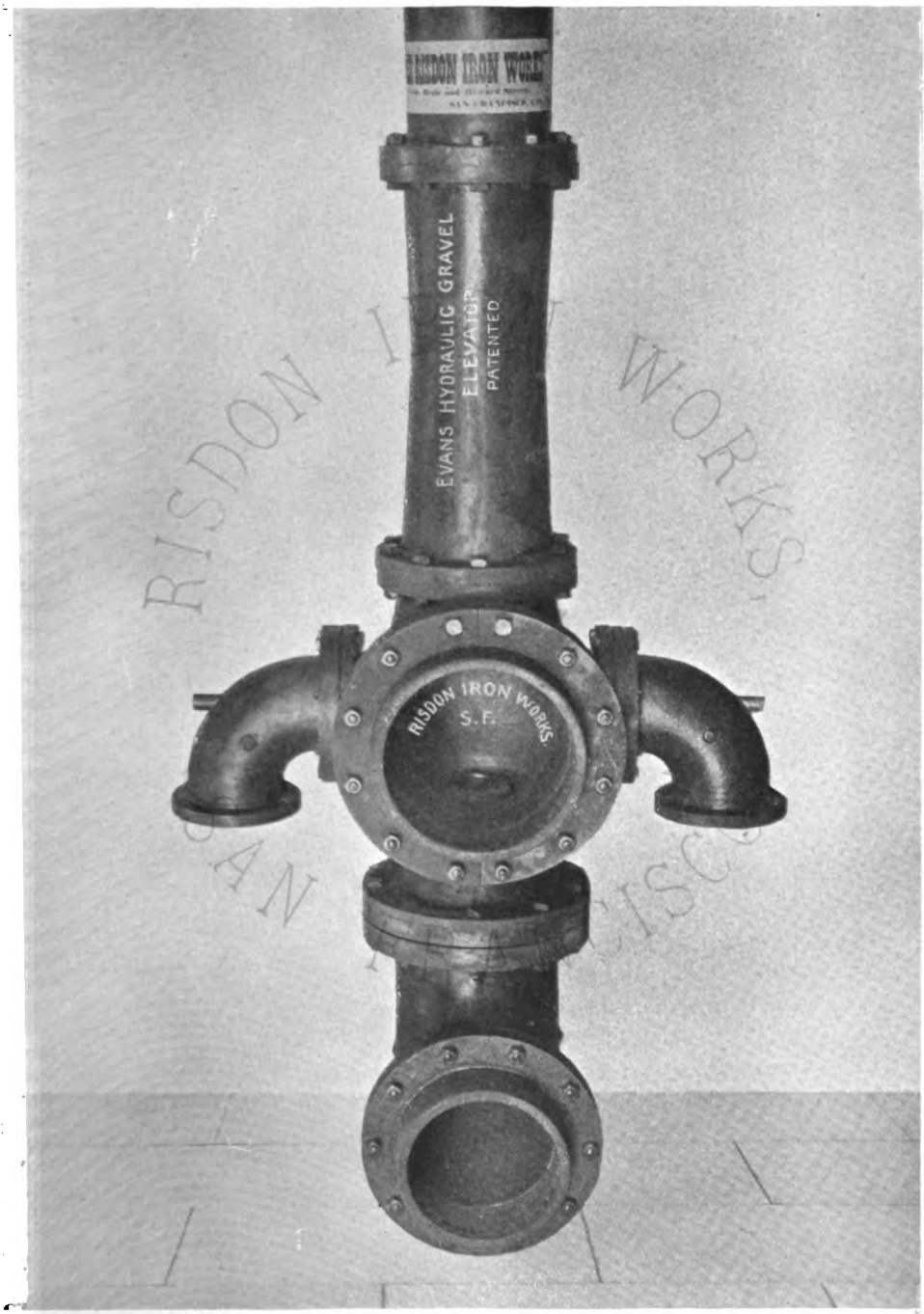


PLATE No. 1.

EVANS HYDRAULIC ELEVATOR.

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Data Required to Estimate Price and Build Evans Hydraulic Elevators.

1st. Quantity of water available.

2d. Quantity of water for giant.

3d. Quantity of water for elevator.

4th. Head of water in feet.

5th. Distance that elevator must lift.

6th. Distance from bedrock to top of bank.

7th. Largest size of gravel to elevate.

On receipt of the above information we will design elevator to fill your requirements.

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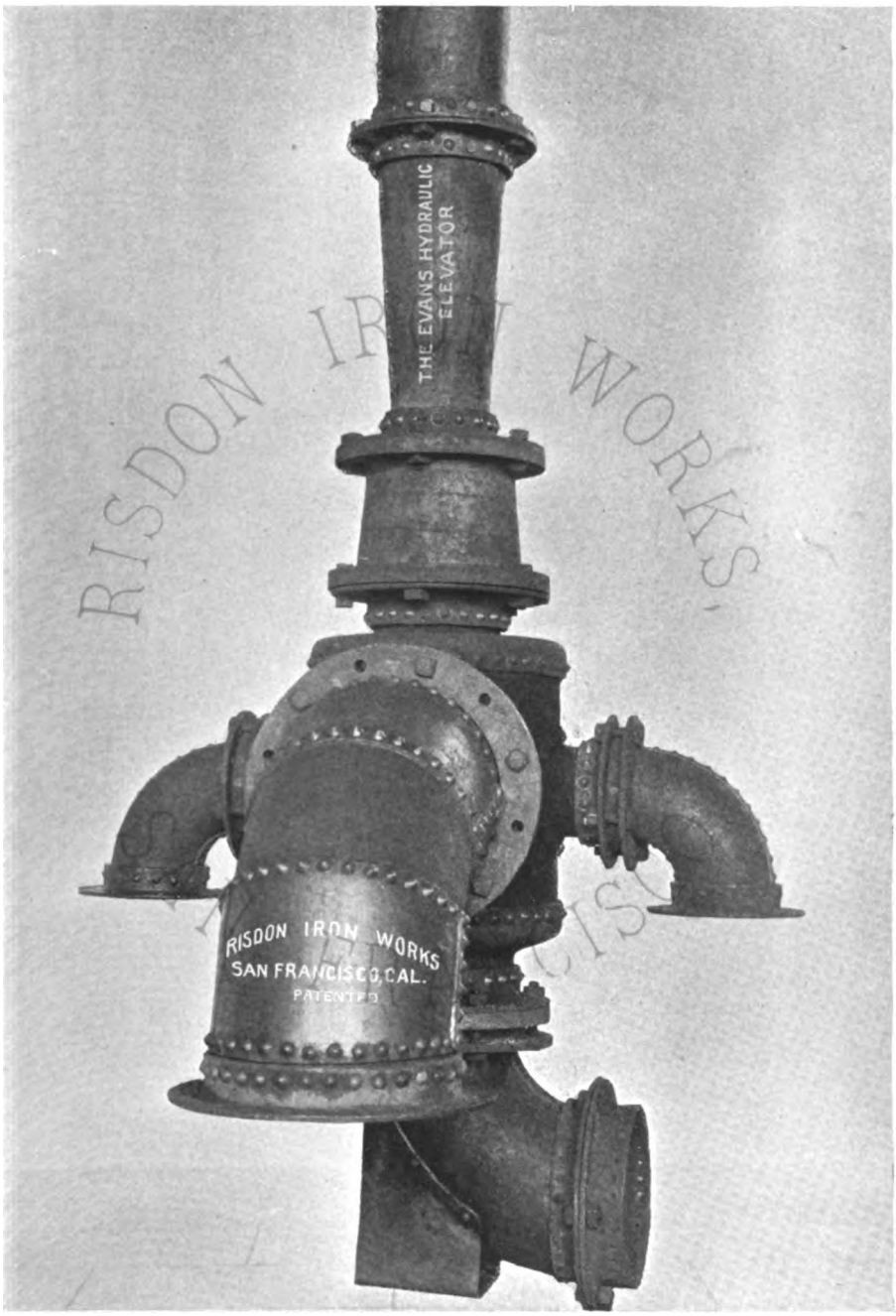


PLATE No. 2.

EVANS HYDRAULIC ELEVATOR.

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PLATES Nos. 3 and 4.

This illustrates a special construction of Evans Elevator, which is designed for permanent work, being placed in bottom of pit, and taking care of all material that passes the nine-inch grizzly, also all water that a five-inch nozzle, under four hundred feet head, can be conveyed down a sluice with a grade of three inches to twelve feet.

The amount of water discharged by giant was nine hundred inches, and the quantity of water used on elevator one thousand inches, discharging three hundred tons per hour.

Plate 4 shows the elevator in position.

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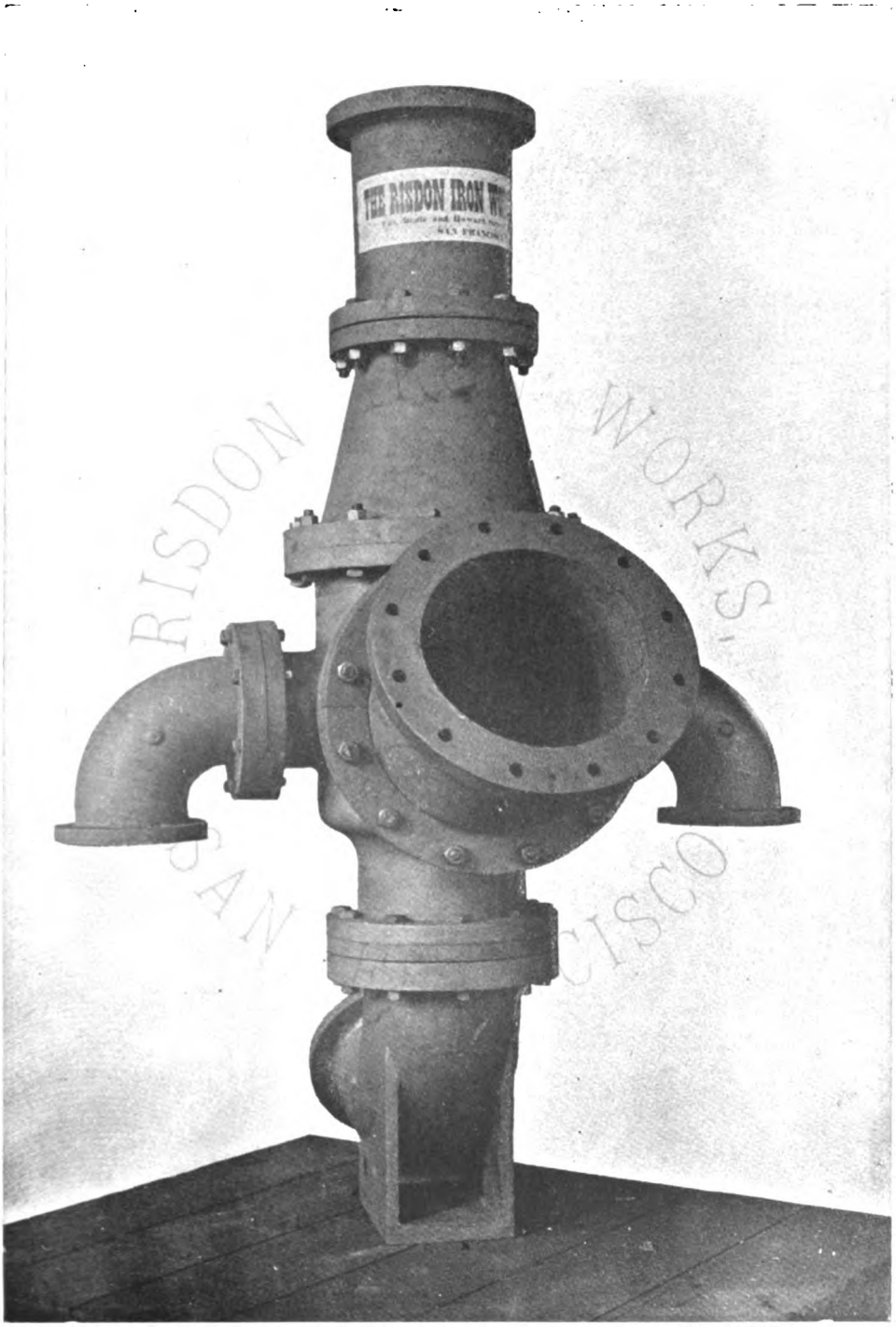


PLATE No. 3.

EVANS SPECIAL ELEVATOR.

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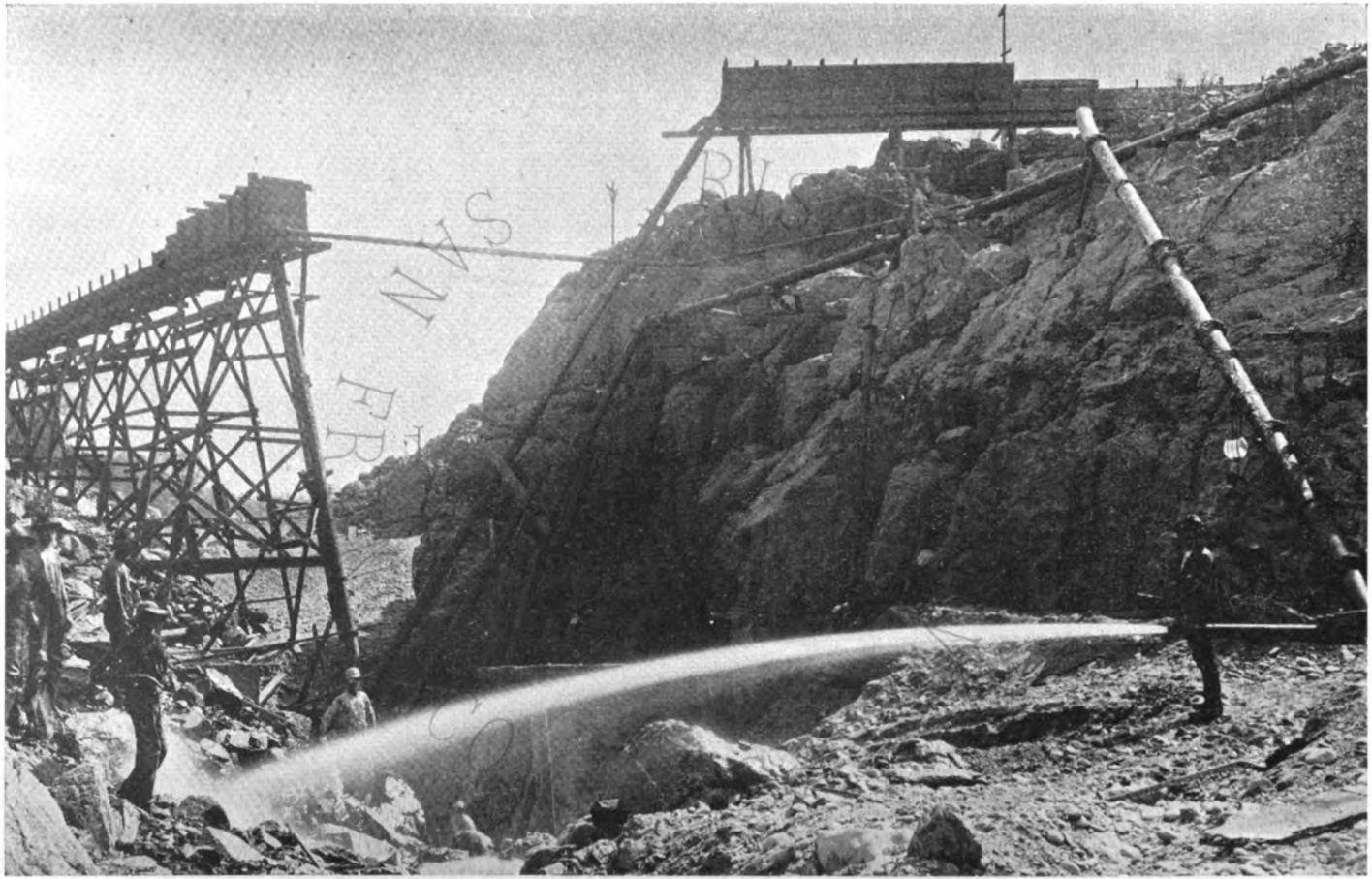


PLATE No. 4. **EVANS HYDRAULIC ELEVATOR AT GOLDEN FEATHER.**

Lift, 50 feet. Head, 300 feet.

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PLATE No. 5.

EVANS HYDRAULIC ELEVATOR AT GOLDEN FEATHER.

Lift, 60 feet. **Head, 300 feet.**

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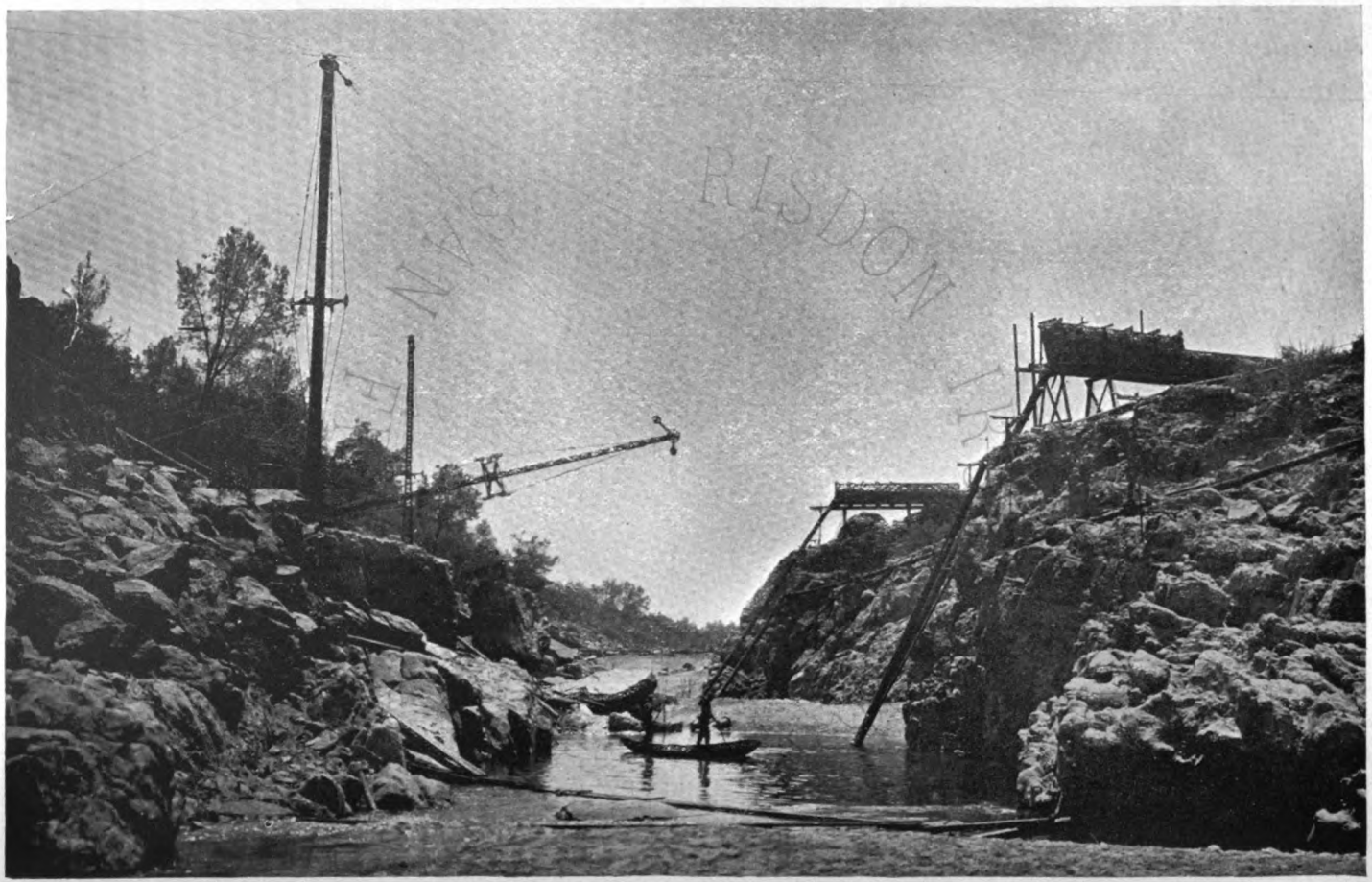


PLATE No. 6. **EVANS HYDRAULIC ELEVATOR IN OPERATION AT OROVILLE, BUTTE CO.**

Lift, 55 feet. Head, 300 feet.

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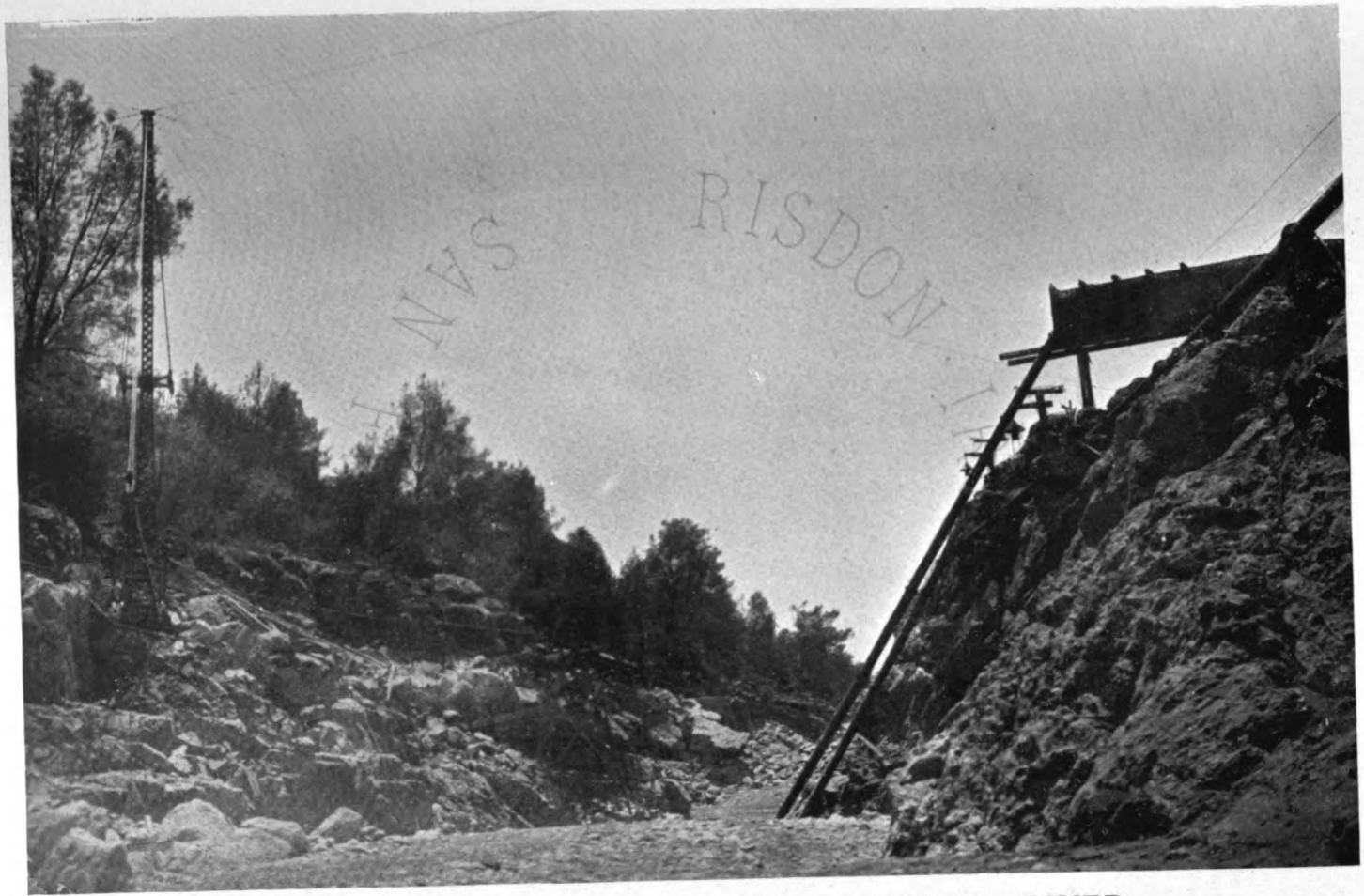


PLATE No. 7. **EVANS HYDRAULIC ELEVATOR, FEATHER RIVER.**

Lift, 65 feet. Head, 400 feet.

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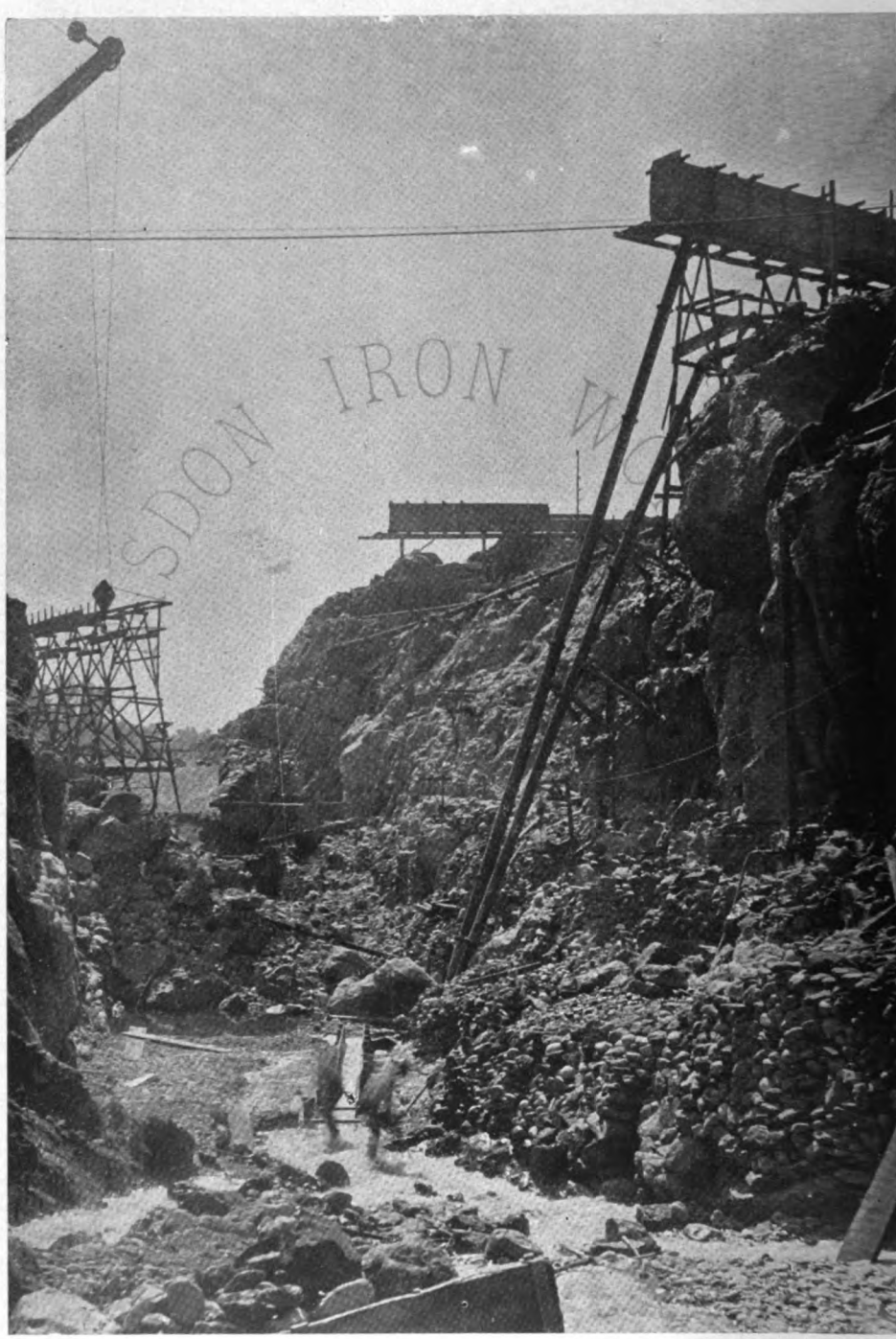


PLATE No. 8.

EVANS ELEVATOR LIFTING SEVENTY FEET.

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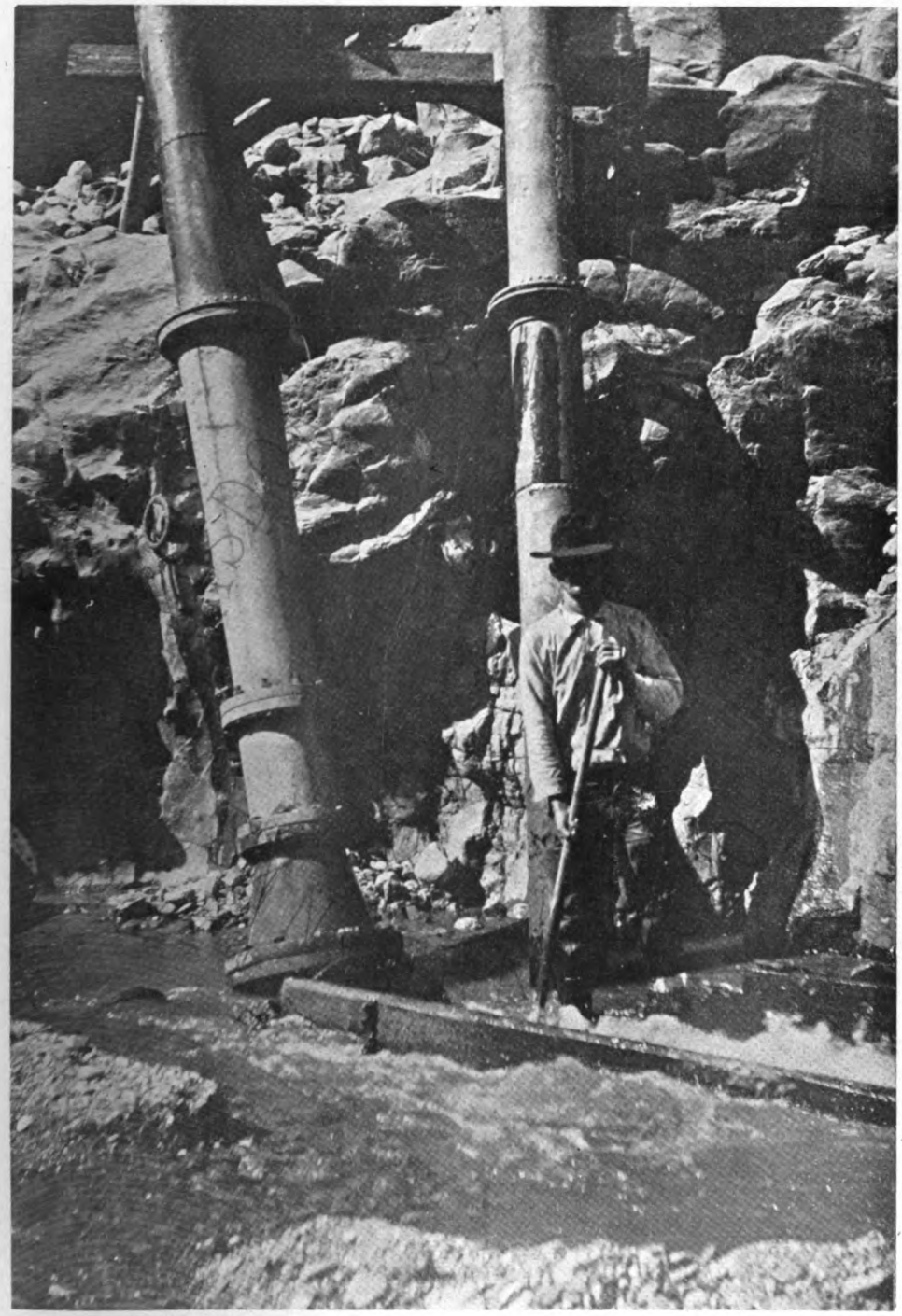


PLATE No. 9.

EVANS ELEVATOR LIFTING SEVENTY FEET.

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PLATE No. 10.

EVANS ELEVATOR LIFTING SEVENTY-TWO FEET.

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PLATE No. 11. GIANT PIPING TO EVANS ELEVATOR.

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PLATE No. 12.

SLUICE LEADING GRAVEL TO EVANS ELEVATOR.

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PLATE No. 5.

This illustration is that of an Evans Elevator lifting gravel sixty feet with a head of three hundred feet, using four hundred inches of water, and discharging seventy-two tons per hour. The largest gravel handled is six inches diameter, the larger rocks being separated by a grizzly.

This elevator, using four hundred inches of water, under 310 feet head, discharged eighteen million gallons in twenty-four hours a distance of fifty-four feet.

PLATE No. 6.

This illustrates two Evans Steel Elevators pumping water and gravel from the Golden Feather, at Oroville, California, and each elevator discharged twenty million gallons per day fifty-five feet high with a head of three hundred feet.

This company operates the largest river mines in this country, and the operation is as follows:

Feather River at Oroville is from two hundred to three hundred feet wide and from twenty to thirty feet deep. This company constructed a head and foot dam 1½ miles apart and placed two Evans Steel Elevators to pump out the river. This was accomplished in 2½ days. The elevation of the gravel required the removal of one elevator; the other handled all the seepage water as well as a large quantity of gravel.

PLATE No. 7.

This half-tone will give an idea of the Evans Elevator lifting gravel up a steep bank and handling all the material that can be piped to it.

This elevator lifted the gravel sixty-five feet with four hundred feet head, and it was found impossible to choke it, although sixteen men and one giant, with a four-inch nozzle, tried for hours.

PLATES Nos. 8 and 9.

These half-tones show the Evans Elevator in operation lifting gravel seventy feet with 380 feet head, and pumping one thousand inches and all the gravel that three hundred inches of water can possibly pipe to the elevator.

PLATES Nos. 10 and 11.

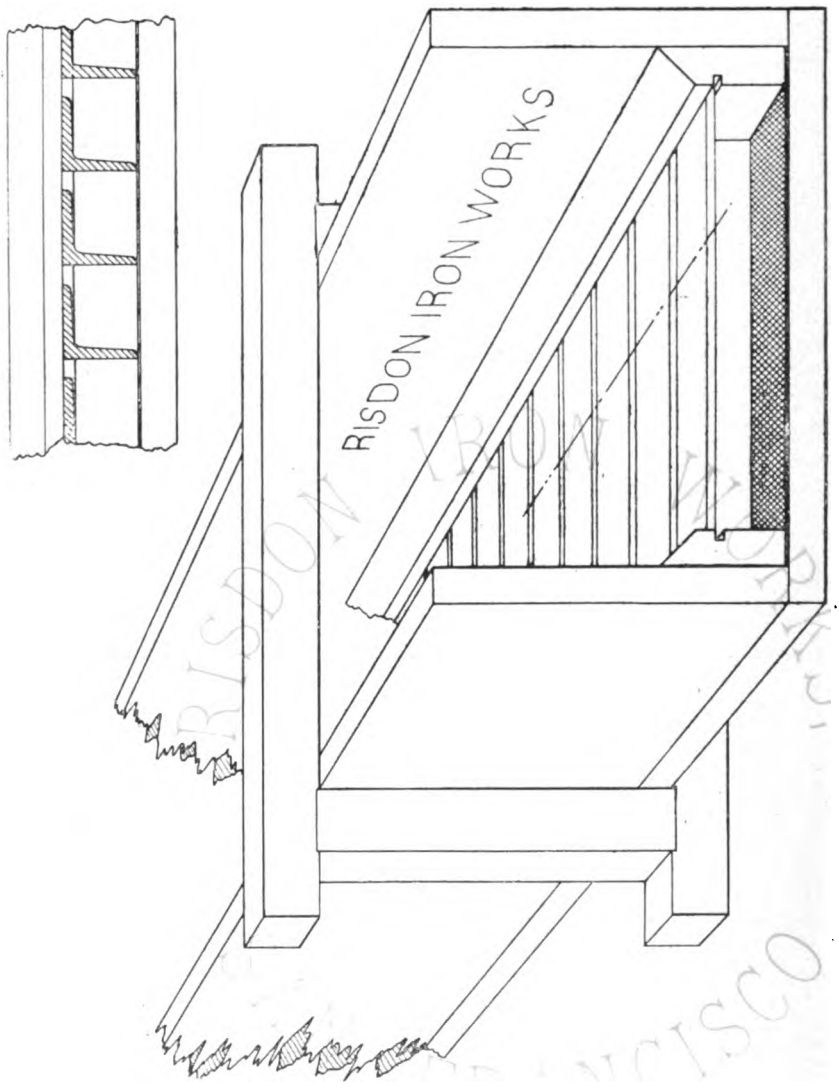
This illustration is of an Evans Elevator lifting gravel seventy-two feet with four hundred feet head.

Plate 11 shows the giant piping the bank.

PLATE No. 12.

This illustration shows the sluice leading to the elevator.

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PATENT RIFFLE FOR HYDRAULIC MINING

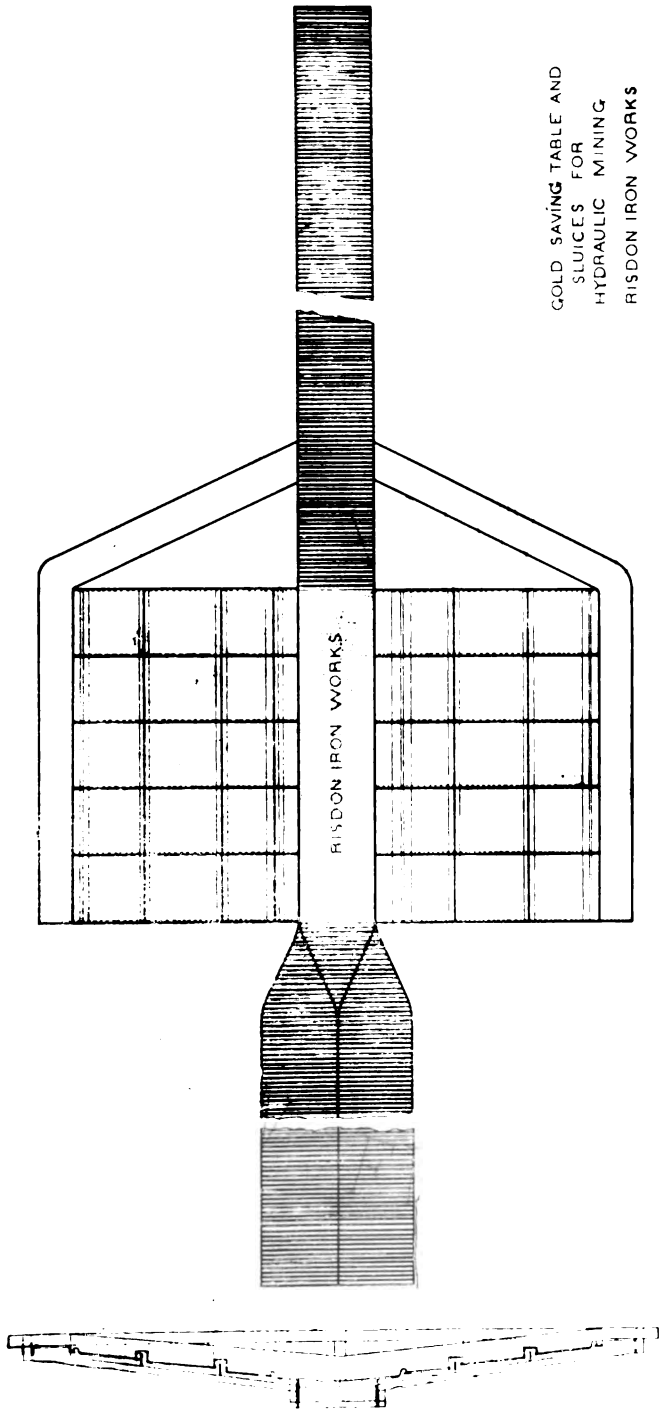
PLATE No. 12.

Riffles.

Plate No. 12 illustrates our improved patent riffles, which we consider the finest gold-saving riffle ever invented, and we recommend their use. They are made of angle or T iron, with cast-iron sides, in two-foot sections, any width; they are easily removed, and, when set on cocoanut matting, save the very finest flour gold. The section will show the mode of construction.

The iron riffle is a great improvement over the old wood or stone riffle, and in plates 12½ and 13, we show them in position on gold-saving tables and in undercurrents.

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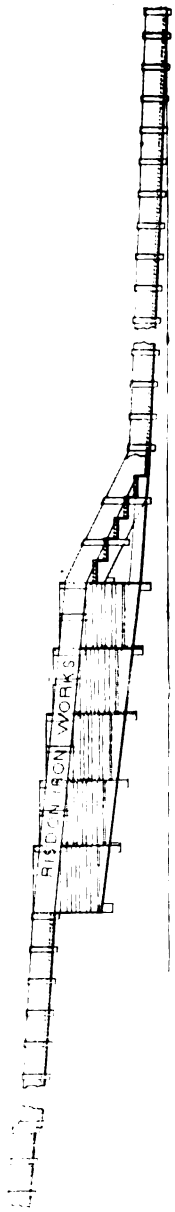


PLATE No. 12½.

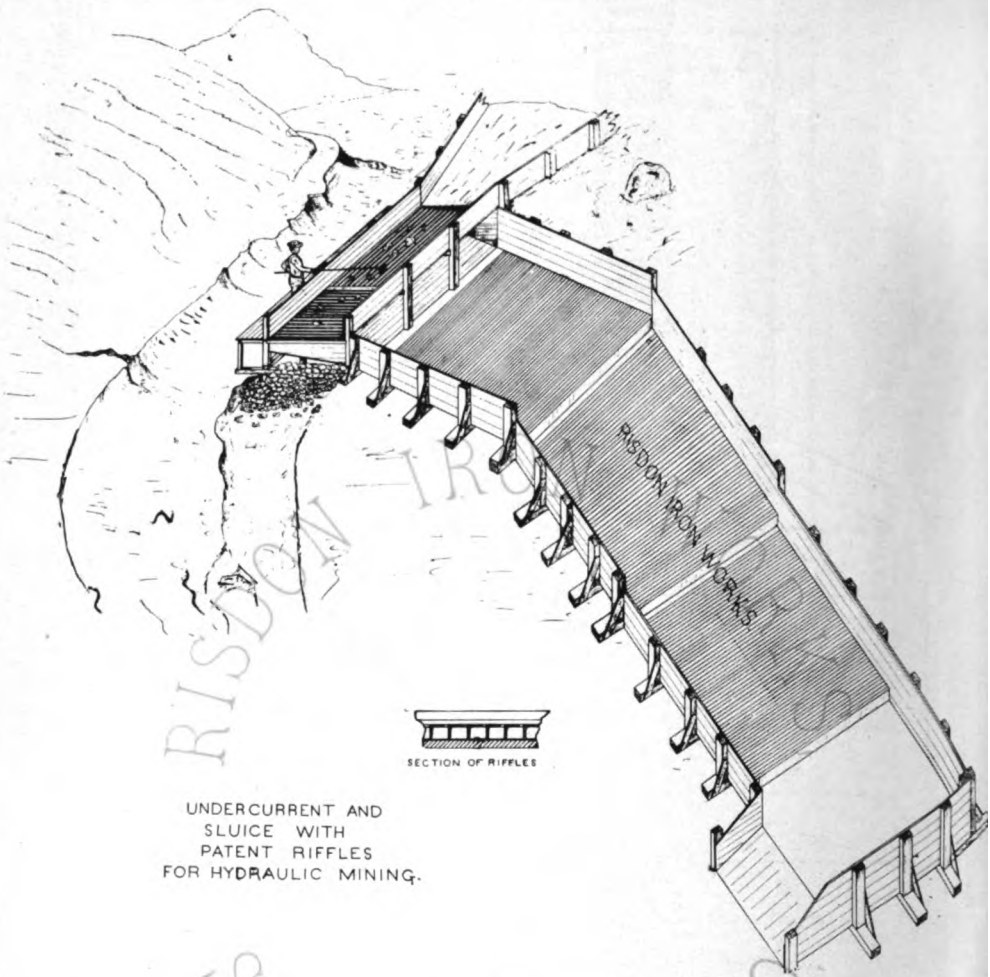
Gold-saving Tables.

Plate No. 12½ illustrates our system of gold-saving tables. We know that they will prove of great advantage to the placer miners, as they can be cleaned up in sections without stopping work.

The riffles are of our improved pattern, as shown on plate 12, and the punched sheet iron greatly facilitates the saving of gold by separating the small rocks that pass the undercurrents.

This system is very largely in use in South America and New Zealand, where it has almost entirely superseded the old-style sluice.

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UNDERCURRENT AND
SLUICE WITH
PATENT RIFFLES
FOR HYDRAULIC MINING.

RISDON IRON WORKS SAN FRANCISCO

PLATE No. 13.

Undercurrents.

Plate No. 13 illustrates a form of undercurrent which we recommend. It is largely in use in this country, British Columbia, South America, and New Zealand. We use our improved riffles.

As the large proportion of the gold is located in the fine gravel, it is found necessary to dispose of the larger boulders and rocks from the sluice as soon as possible; and, for this purpose, undercurrents are used. On construction, as shown in cut, the end on the main sluice is covered by a grating with spaces from one to two inches apart, made of one-half by three inch iron or one inch square iron. This allows all fine particles to drop to the lower sluice, and coarse particles are dumped out over the end of the grating. The fine particles run over the riffles, and the gold is caught without difficulty.

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Improved Form of Hydraulic Giants

AS USED IN THE

HYDRAULIC GRAVEL MINES.

We desire to call attention of miners to our new hydraulic machine, or NEW GIANT, which is the best machine ever offered. We have dispensed with the center bolt used in the old style, and which was so liable to catch trash.

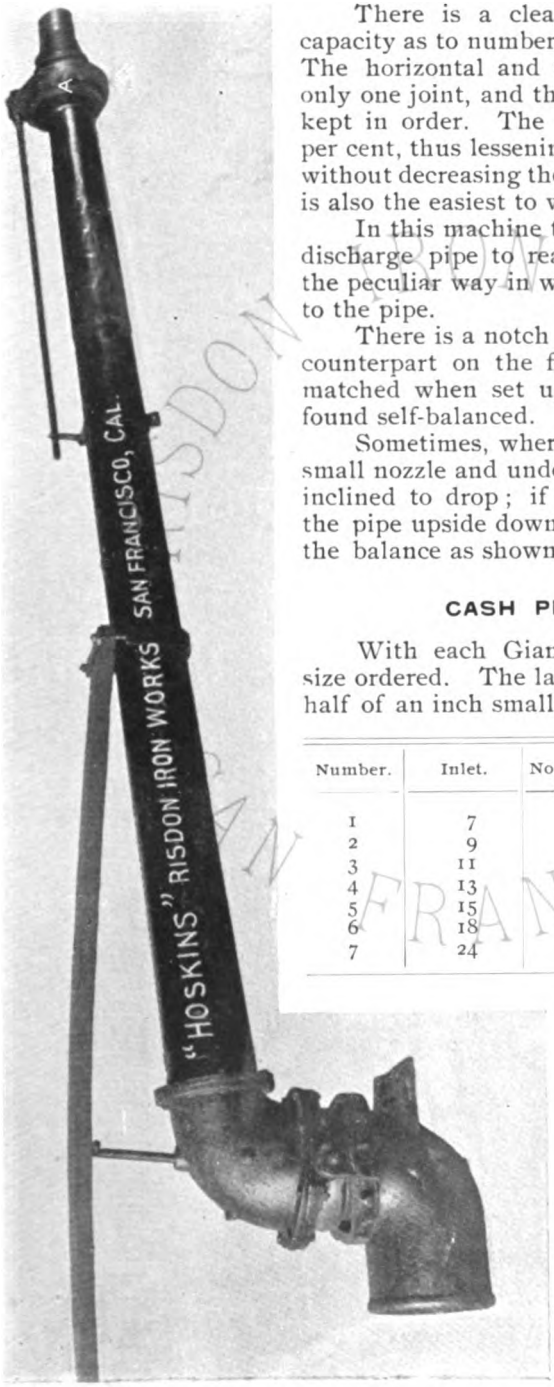


PLATE No. 14.

There is a clear waterway through, and the capacity as to number of size is also greatly increased. The horizontal and vertical motions are made with only one joint, and that a very durable one, and easily kept in order. The weight is reduced about twenty per cent, thus lessening the cost of transportation, and without decreasing the strength. The style of machine is also the easiest to work of any yet tried.

In this machine there would be a tendency in the discharge pipe to rear up. This is counteracted by the peculiar way in which the nozzle butt is attached to the pipe.

There is a notch on the flange of the pipe, and its counterpart on the flange of elbow; these should be matched when set up, and the pipe will usually be found self-balanced.

Sometimes, where a large machine is used with a small nozzle and under low pressure, the pipe may be inclined to drop; if so, reverse the notches, turning the pipe upside down; if that does not answer, apply the balance as shown in cut.

CASH PRICES OF GIANTS.

With each Giant we furnish two nozzles as per size ordered. The largest size should be at least one-half of an inch smaller than the nozzle butt.

Number.	Inlet.	Nozzle Butt.	Weight, about	Price.
1	7	4	200 lbs.	$ 75 00
2	9	5	360 "	100 00
3	11	6	610 "	125 00
4	13	7	675 "	175 00
5	15	8	770 "	225 00
6	18	9	1,200 "	350 00
7	24	10	1,500 "	470 00

Larger sizes made to order. Reasonable charges for extra work.

We can supply deflectors at manufacturers' prices. These are great labor-saving appliances. With the aid of a deflector a child can manipulate the largest size machine. They are applied as shown in the cut.

Send for Discounts.

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Deflector for Hydraulic Giants.

Letter A. PLATES Nos. 14 and 15.

The Deflector is a valuable adjunct to all hydraulic machines. With it much more work is accomplished and with much less labor.

Suppose it takes a force of one hundred pounds applied at the end of the discharge pipe to rotate the machine: this is heavy work for the pipeman, and he moves the pipe by jerks, and with difficulty gets the stream to strike the bank just where he wishes it. With the Deflector, ten pounds' force at the end of the lever will move the pipe in any direction with the greatest facility, and the stream can be directed to any point with certainty. A rock pile can be stirred up or a sand streak followed, and all operations accomplished with perfect ease.

Double the work is accomplished when a Deflector is used.

CASH PRICES OF DEFLECTORS.

Size nozzle butt, inches.....	4	5	6	7	8	9	10
Price.....	$50 00	$55 00	$60 00	$65 00	$70 00	$75 00	$80 00
Weight, pounds	30	40	45	55	70	85	110

Volumes of Water Required for Effective Use in Operating Hydraulic Giants.

Head Feet.	2-inch Nozzle. Miner's Inches.	2½-inch Nozzle. Miner's Inches.	3-inch Nozzle. Miner's Inches.	4-inch Nozzle. Miner's Inches.	5-inch Nozzle. Miner's Inches.
100	80	125	185	325	500
150	100	155	225	400	625
200	115	180	260	460	715
250	130	200	290	515	800
300	140	220	320	565	880
350	150	240	345	610	950
400	160	255	365	650	1000

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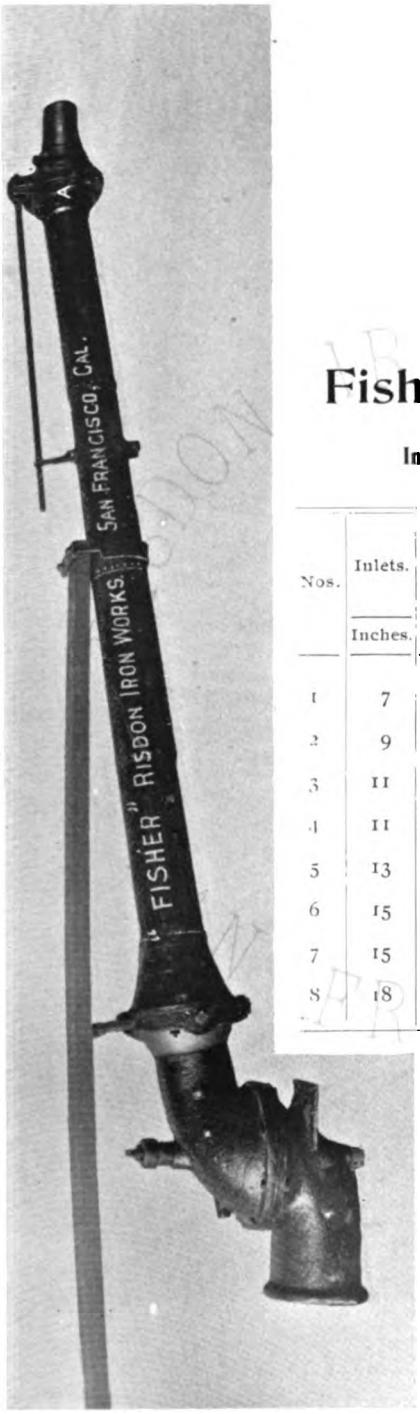


PLATE No. 15.

PRICE LIST

Fisher Hydraulic Giant,

Including Two Nozzles to Each Machine.

Nos.	Inlets.	Outlets	Diameter of Nozzle Butts Inside.	Sizes Nozzles.	Shipping Weights.	Weights of Heaviest Parts.	Prices.
	Inches.	Inches.	Inches.	Inches.	Lbs.	Lbs.	
1	7	5½	4	2 and 3	390	120	$125
2	9	7	5	3 and 4	515	150	175
3	11	7½	6	3 and 4	805	210	225
4	11	9½	7	4 and 6	905	225	250
5	13	9½	8	5 and 6	1300	335	300
6	15	9½	9	6 and 7	1695	520	350
7	15	11	10	6 and 7	1915	520	400
8	18	11	10	7 and 8	2075	605	450

Send for Discounts.

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A "Miner's Inch" of Water.

The term "miner's inch" is distinctively of California origin, having grown out of the method of measurement adopted by the various ditch companies in disposing of water to their customers.

A miner's inch of water varies in different localities to such an extent that it may almost be said to constitute an arbitrary quantity. Efforts have been made from time to time to make a miner's inch a fixed and uniform quantity of water. For various reasons this has failed, and we give below the measurements used by the principal ditch companies in California.

Measurement of Water by Different Ditch Companies in California.

DITCH COMPANIES.	Opening, Inches.	Pressure Board, Inches.	Mean Pressure, Inches.	Cubic Feet.
Amador Canal Co.	2	4	5	1.40
Eureka Lake and Canal Co.	2	5	6	1.45
Park Canal and Mining Co.	2	5	6	1.45
Eldorado Water and Deep Gravel Mining Co.	4	4	6	1.45
Mok. and Campo Seco Canal and Mining Co.	4	3	5	1.40
Union Water Co., Murphy's	4	4	6	1.45
South Yuba Canal Co.	4	4	6	1.45
North Bloomfield	2	6	7	1.60
Milton	2	6	7	1.60
La Grange	2	6	7	1.60
Smartsville Ditch Co.	4	7	9	1.78

The North Bloomfield, Milton and La Grange companies measure through a 3-inch plank; the others use 1 and 1½ inch planks.

For Usual Calculations.

A flow of one miner's inch of water is equal to the supply of:

	Gallons.	Cubic Feet.
Per second	.1875	.025
Per minute	11.25	1.5
Per hour	675	90
Per day	16,200	2,160

Or a flow of one cubic foot

Per second equals 40 miner's inches.

Per minute equals ⅔ miner's inches.

Per hour equals .01110+ miner's inches.

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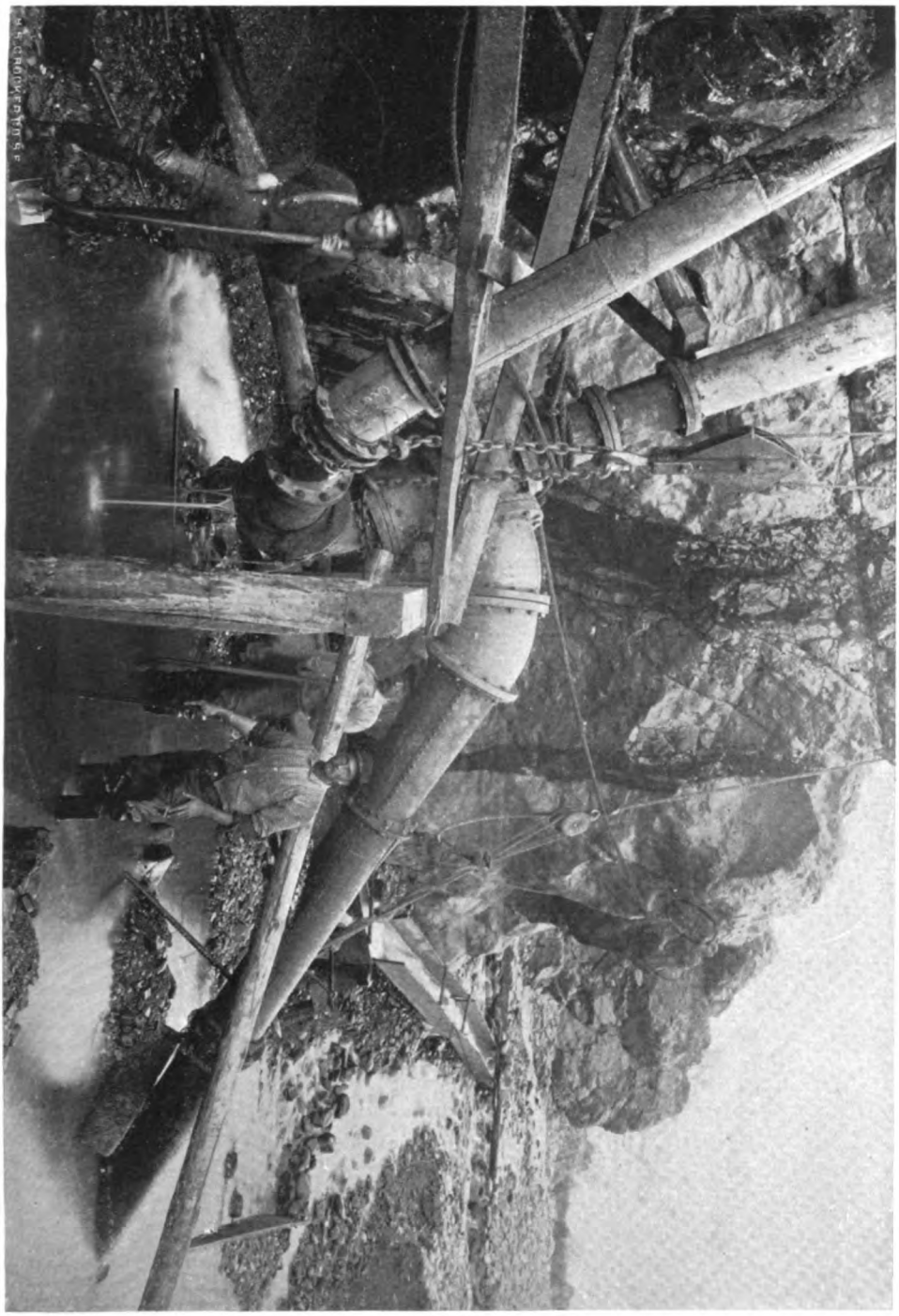


PLATE No. 16.

EVANS HYDRAULIC ELEVATOR,

FEATHER RIVER.

IN OPERATION SINKING TO BEDROCK.

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PLATE No. 17.

EVANS HYDRAULIC ELEVATOR, FEATHER RIVER.

LIFT, 72 FEET. HEAD, 400 FEET. SHOWING ELEVATOR SUPPORTED ON SCAFFOLD.

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The Duty of a Miner's Inch of Water.

The only known attempts at any extended and detailed investigation of the duty of the miner's inch have been made by the North Bloomfield and the La Grange Hydraulic Mining Companies. The results of the work performed at these mines are given in the annexed tabulated statements:

North Bloomfield Mine.

Years.	Cubic yards of gravel washed.	Miner's 24-hour inches.	Grades.	Cubic yards washed per miner's inch.	Cub. ft. of water used per cub. ft. of gravel moved.	Height of bank.	Remarks.
1870–74	3,250,000	710,987	6½ in. to 12 ft.	4.6	18	100 ft.	Sluices 6 ft. wide, 32 in. deep. Riffles principally blocks (wood), but rock riffles in tail sluices. The larger portion of the material moved was top gravel.
1875	1,858,000	386,972	" " "	4.8	17	100 "	
1876	2,919,700	700,000	" " "	4.17	20	200 "	
1877	2,993,930	595,000	" " "	3.86	21	265 "	
Totals	11,021,630	2,392,959	.....	4.6	18	.....	

La Grange Mine.

Years.	Names of claims.	Cubic yards of gravel washed.	Miner's 24-hour inches.	Grades.	Cubic yards washed per miner's inch.	Cub. ft. of water used per cub. ft. of gravel moved.	Height of banks.	Remarks.
1874–76	French Hill.	676,968	624,745	4 in. to 16 ft.	1.08	74	10 to 48 ft.	
1875–76	Light.	683,244	375,155	" " "	1.82	43.9	6 "	Sluices 4 ft. wide and 30 in. deep, paved with blocks.
1874–76	Chesnau.	284,932	207,010	" " "	1.37	58	50 to 80 "	
1875–78	Kelley.	459,570	302,960	" " "	1.52	52	40 to 50 "	
1880–81	Vigno Hill.	329,120	203,325	" " "	1.57	50	10 to 80 "	
Totals	.....	2,433,834	1,713,195	.....	1.42	56	.....	

In general it can be stated that the duty of a miner's inch is governed by the size, capacity, character of pavement and grade of the sluices, coupled with the supply of water. A heavy grade will compensate for a limited supply of water. With an abundant supply of water and material the capacity of the sluices will depend upon:

First—The character of the material washed.

Second—The size and minimum grade of the sluices.

Third—The character of the riffles used, and, correlatively, the duty of the miner's inch.

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HYDRAULICS.

TABLES AND THEIR USES.

The following tables, by which any one, however unskilled, is enabled at a glance to solve many of the more difficult and important problems in hydraulics, have been computed from a large amount of data obtained by the most careful experiments of the ablest engineers. It is, therefore, with assurance that these tables are commended as the most simple and reliable of any extant.

Flow of Water Through Rectangular Orifices in Thin Vertical Partitions.

Question.—The head being 10 feet, and the gate-opening being 6 inches high and 1 foot wide, what will be the discharge in miners' inches?

Answer.—In this table, opposite 10 feet in first column, find in column headed "6 inches high, 1 foot wide," 7.62 cubic feet. Multiply this number by 50, the number of miners' inches in one cubic foot, and there results $762 \times 50 = 381.00$ miners' inches.

Question.—The head being 25 feet, and the opening 1.5 inches high, 1 foot wide, how many pounds will be discharged per second?

Answer.—In this table, opposite 25 feet in first column, find in column headed "1.5 inches high, 1 foot wide," 3.05 cubic feet. Multiply this number by 62.5, the number of pounds in a cubic foot: $3.05 \times 62.5 = 190.625$ pounds.

Question.—The head being 7 feet, and the opening 1 inch high, 1 foot wide, what will be the discharge in cubic feet?

Answer.—In this table, opposite 7 feet in first colmun, find in column headed "3 inches high, 1 foot wide," 3.24 cubic feet. The given height 1 inch is one-third of 3 inches, the height of the opening; hence, without sensible error, we may take one-third the flow due 3 inches for that opening: $3.24 \div 3 = 1.08$.

Flow of Water Over Weirs per Second for Each Foot in Length of Weir.

Question.—The head from still water being 8.4 inches, what is the flow for 1 foot in length over weir?

Answer.—In the third column of this table is found the given head 8.4 inches, opposite which in the fourth column find 1.96 cubic feet, the required flow.

Question.—The head from still water being 2 feet 6 inches, what is the flow in miners' inches over 1 foot length of weir?

Answer.—In the fifth column of this table is found 2.6 the given head, opposite which in column six will be found 13.167 cubic feet flow per second. This multiplied by 50, the number of miners' inches in one cubic foot flow per second, gives $13.167 \times 50 = 658.35$ miners' inches.

Flow of Water Through Clean Iron Pipes.

REMARKS.—In the analysis of the flow of water, the total head is divided into three parts, viz: 1st, that portion of the head due to the velocity; 2d, that portion which overcomes the resistance of entry; and 3d, that portion which overcomes the resistance within the pipe. In long pipes, the two former portions as compared with the latter portion of the total head are quite small. In this table the greatest velocity in any pipe is 13.445 feet per second, due to 4.2 feet, the sum of the first and second portions of the total head, while the third portion of the head is 211.2 feet. The head or fall in this table refers to the third portion of the total head. This table has been computed on the assumption that the length of any pipe is not less than 1,000 times its diameter.

Question.—The fall being 52.8 feet per mile, what will be the flow through a pipe 22 inches in diameter, in cubic feet, also in miners' inches?

Answer.—In this table find in first column 52.8 feet, opposite which in column headed 22 inches will be found the required quantity, viz, 21.06 cubic feet, which, multiplied by 50, gives 1,053 miners' inches.

Question.—The diameter of the pipe being 24 inches, what fall will be required for the pipe to carry 1,000 miners' inches.

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Answer.—In this table, in column headed 24 inches, find that number which multiplied by 50 will make the 1,000 miners' inches given. In this case, the nearest number is 20.42, opposite which in column headed fall per mile will be found 31.68 feet, the fall required.

Question.—In carrying 1,050 inches of water to a hydraulic mine in a pipe 27 inches diameter, having a fall of 95.04 feet to the mile, what will be the effective head at the mine?

Answer.—In this table, in column headed 27 inches, find that number which multiplied by 50 will make 1,050 approximate miners' inches. In this case, we have 21.13 cubic feet, opposite which, in column headed fall per mile, we find 18.48 feet, which is the head per mile lost in carrying the water. Subtracting this from the given fall or head gives the effective head. Thus 95.04—18.48=76.56 feet effective head.

Question.—There being 7.5 gallons in a cubic foot, and 86,400 seconds in a day (twenty-four hours,) the fall 7.39 feet per mile, how many gallons will a pipe 40 inches diameter carry per day?

Answer.—In this table, in column headed 40 inches and opposite 7.39 feet headed fall per mile, will be found 37.57 cubic feet flow per second. Then 37.57×7.5×86,400=24,345,360 gallons.

GENERAL RULE.—The velocity per second is equal to 50 times the square root of the product of the head and diameter in feet, divided by the sum of the length and 50 times the diameter of the pipe in feet.

SHORT PIPES.—This rule applies to both long and short pipes, and is approximately accurate if the diameter does not exceed two feet.

Additional Head Necessary to Overcome the Resistance of One Circular Bend.

Question.—The radius of the pipe being to the radius of the bend in the ratio of 1 : 5, the number of degrees in the bend being 90 degrees, and the velocity 75 feet per second, what is the additional head required to overcome the resistance of the bend?

Answer.—In this table, in first column headed velocity per second, find 75 feet, opposite which in column headed 1 : 5 90 degrees is found 6.03 feet, the required head.

Question.—The radius of the pipe being to the radius of the bend in the ratio of 2 : 5, the number of degrees in the bend being 120 degrees, and the velocity per second 100 feet, what is the additional head required to overcome the resistance of one bend?

Answer.—In this table, opposite 100 feet velocity, will be found in column headed 2 : 5, 120 degrees the required number, viz, 21.34 feet.

Additional Head Required to Overcome One Angular Bend.

Question.—The velocity being 40 feet per second, what additional head is required to overcome the resistance of an angular bend whose angle of deflection is 90 degrees?

Answer.—In this table find in column headed velocity per second 40, opposite which, in column headed 90 degrees head, will be found 24.45 feet, the additional head required.

Flow of Water Through Nozzles.

Question.—The head being 125 feet, how many cubic feet per second will a nozzle 4 inches in diameter discharge? How many miners' inches?

Answer.—In this table find in the first column the given head 125 feet, opposite which, in column headed 4 inches, will be found the required quantity, viz, 7.28 cubic feet, and 7.28x50=364 miners' inches.

Question.—Between the inlet and the nozzles of a hydraulic pipe 3 feet in diameter, the distance is 5 miles and the total fall 275 feet. The pipe is to carry 2,000 miners' inches of water, which is to be discharged through two "Little Giants," or nozzles equal in size. What will be the loss of head by the resistance in the main pipe? What will be the size of each nozzle?

Answer.—In table showing "Flow of Water through Clean Iron Pipes" find in column headed 36 inches that number which multiplied by 50 will make 2,000, the given number of miners' inches. In this case, 40.86 approximates sufficiently near, opposite which, in column headed fall per mile, is found 14.78 feet, the loss of head per mile. Multiply this by 5, the length of the pipe, and we have 14.78×5=73.9 feet, the loss of resistance in the pipe 5 miles long. Subtracting this from the total head, 275—73.9=201.1 feet remaining head. Again, in same table, find 200 nearest 201.1 feet in column headed head, opposite which, in column headed 6 inches, is found 20.64, which multiplied by 50 gives 1,032, or approximately 1,000 miners' inches, which each nozzle is required to discharge. Hence, the nozzles are to be 6 inches in diameter each.

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Relation of Clean, Slightly Rough and Very Rough Pipes with Respect to Their Carrying Capacity.

CLEAN PIPES.—The tables, as appear by the headings, have been computed for clean pipes, in other words, smooth and straight.

SLIGHTLY ROUGH PIPES.—When the pipe is slightly rough multiply the tabulated number for clean pipes by the decimal .886 to determine its carrying capacity.

VERY ROUGH PIPES.—If the pipe is *very rough* multiply the tabulated number for clean pipes by the decimal .773 to determine its carrying capacity.

Relation of the Inlet Forms of Pipes with Respect to the Coefficients of Entrance.

COEFFICIENTS.—Of the three following forms, viz, *Bell Mouthed*, *Square Edged* and *Square Edged* projecting into the reservoir, their coefficients will be in order .900, .836 and .734.

Flow of Water in Open Channels, Base to Perpendicular of Side Slope Being as 3 : 4.

Question.—The dimensions of a canal being top width 11 feet, bottom width 5 feet, depth 4 feet, and the fall per mile 8 feet. Required the number of inches, miners' measure, that it will carry.

Answer.—In this table, in column headed fall per mile, find 8 feet, opposite which, in column headed with given specifications (11, 5, 4), is found 104.8 cubic feet, the flow per second. This multiplied by 50, the number of miners' inches equal to one cubic foot flow per second, gives 104.8×50=5,240 miners' inches required.

Flow of Water in Open Channels, Base to Perpendicular of Side Slope Being as 2 : 1.

Question.—Required the number of cubic feet of water that will flow in a canal whose top width is 40 feet, bottom width 20 feet, depth 5 feet, and whose fall is 2 feet per mile.

Answer.—In this table, in column fall per mile, find 2 feet, opposite which, in column headed with the given specifications (40, 20, 5), is found the required flow, viz, 376.1 cubic feet.

Relative Carrying Capacity of Open Channels Whose Sectional Areas Are Equal to Each but of Different Forms.

The form in which the bottom width is made equal to one of the sides, and in which the base to the perpendicular of the side slope is as 3 : 4, has been adopted as the standard form when the ground will admit, it being the simplest of construction.

The relative carrying capacity for trapezoidal form—base : depth of slope : : 3 : 4; bottom width : depth : : 5 : 4. Coefficient of capacity, 1,000.

Trapezoidal form—base : depth of slope : : 1 : 1; bottom width=depth, .994.

Flume—2 : 1, .961; semi-hexagonal, 1.008; square, .925; semi-circular, 1.056.

Question.—The fall being 6 feet per mile, the sectional area of a square flume 8 square feet, what will be its carrying capacity per second?

Answer.—In table showing "Flow of Water in Open Channels," base to perpendicular of side slopes being as 3 : 4, in column of fall per mile find the given fall 6 feet, opposite which, in column headed sec. 8.0 sq. ft., is found 13.65 cubic feet. This multiplied by the coefficient for a square, viz, .965, gives 13.64×.925=12.63 cubic feet.

REMARKS.—The tables for the flow of water in open channels have been computed upon the assumption that the canals are smooth and straight.

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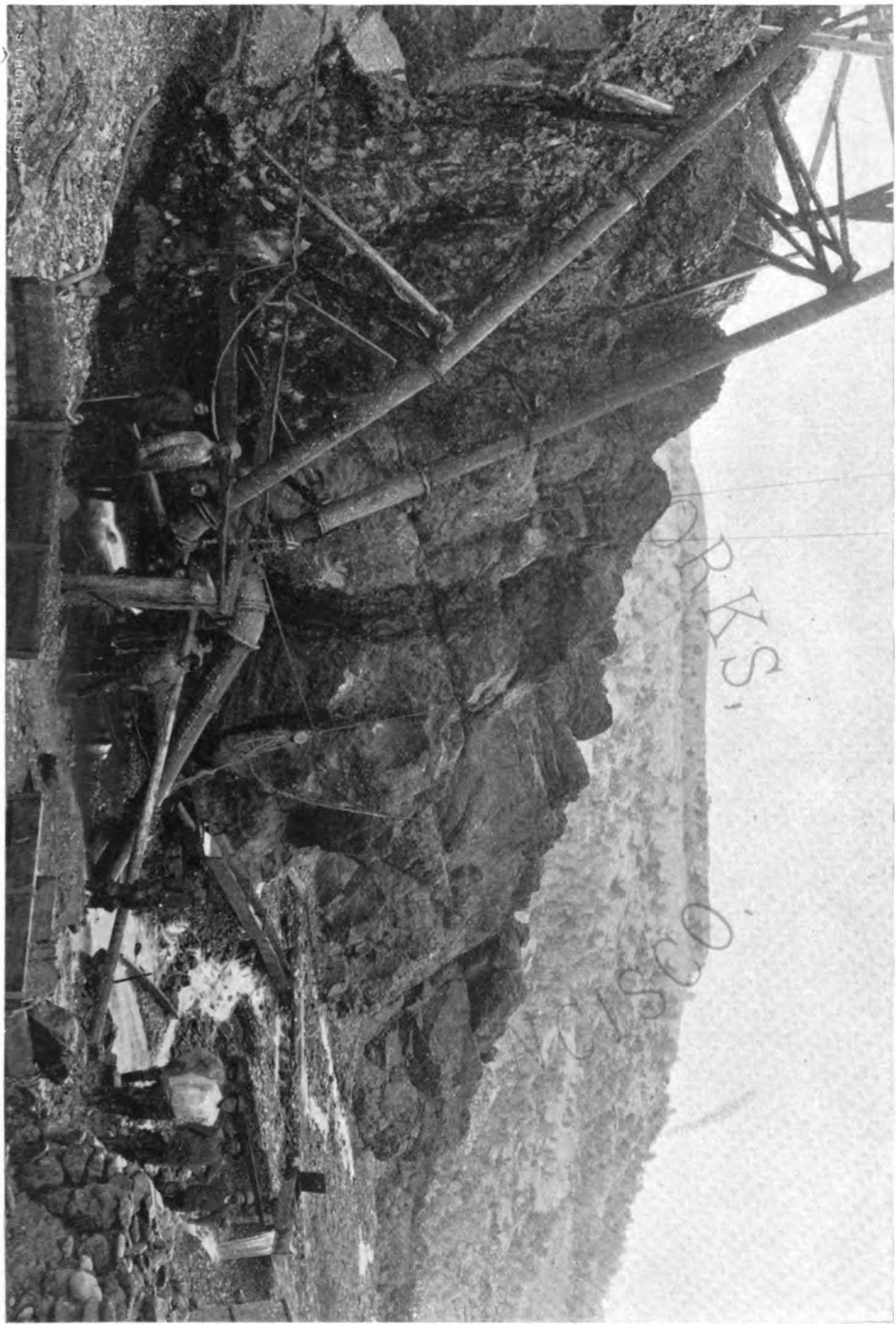


PLATE No. 18.

EVANS HYDRAULIC ELEVATOR,

FEATHER RIVER.

LIFT, 72 FEET. HEAD, 400 FEET. SINKING TO BEDROCK, SHOWING SURFACE WATER.

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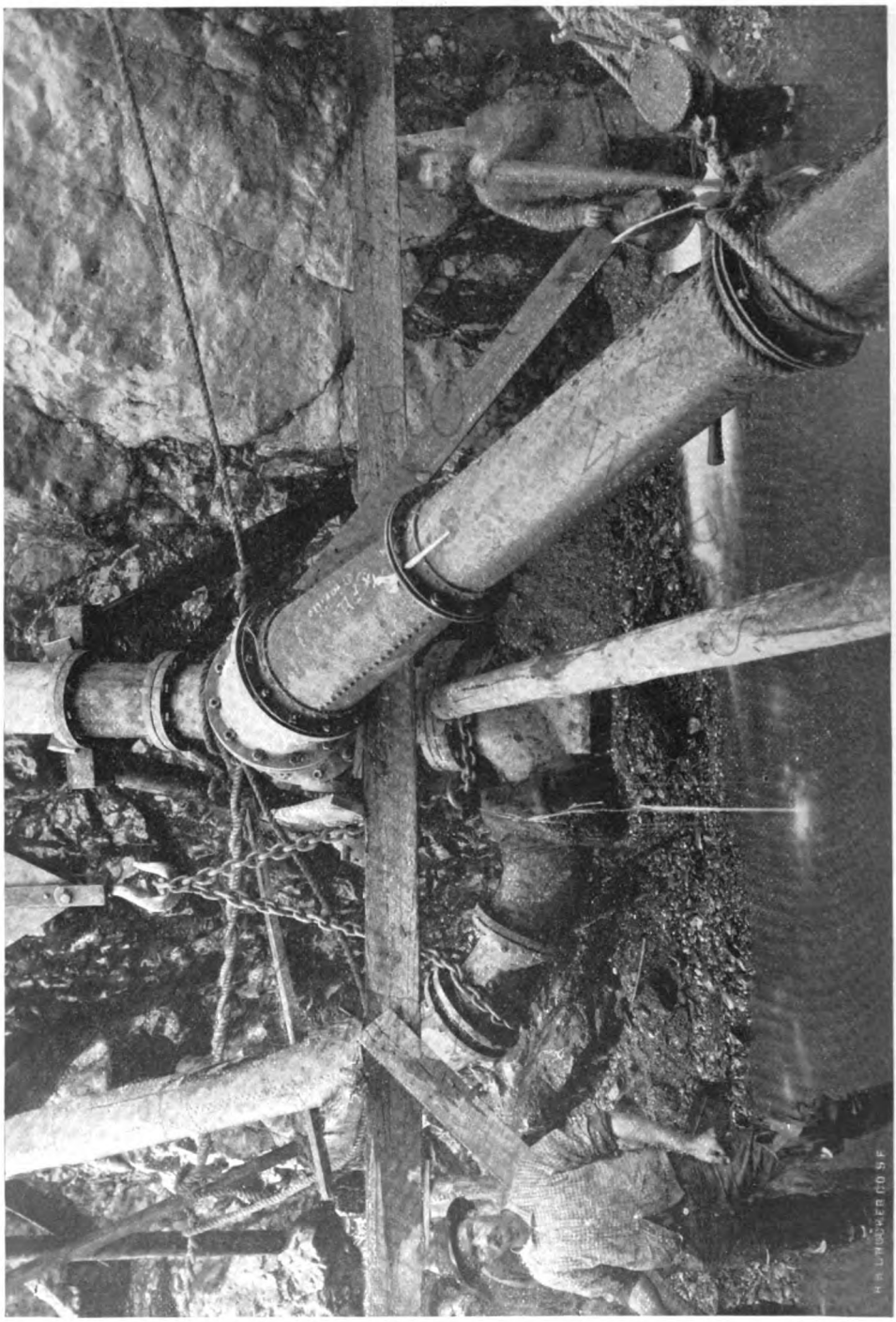


PLATE No. 19.

EVANS HYDRAULIC ELEVATOR,

FEATHER RIVER.

SHOWING ELEVATOR SUPPORTED WHILE SINKING TO BEDROCK.

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TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod Ft.	Fall Per Rod In.	Diameters. ½ in. Cu. ft.	¾ in. Cu. ft.	1 in. Cu. ft.	1½ in. Cu. ft.	1¾ in. Cu. ft.	2 in. Cu. ft.
21.12	0	0.792	.....	.....	.....	.....	.....	.02584
26.40	0	9.990	.....	.....	.....	.....	.02014	.02924
31.68	0	1.188	.....	.....	.....	.01460	.02270	.03274
36.96	0	1.396	.....	.....	.....	.01583	.02426	.03492
42.24	0	1.584	.....	.....	.00567	.01707	.02638	.03776
47.52	0	1.782	.....	.....	.00617	.01816	.02838	.04081
52.80	0	1.980	.....	.00316	.00677	.01963	.02988	.04321
63.36	0	2.376	.00122	.00350	.00781	.02123	.03260	.04843
73.92	0	2.772	.00124	.00377	.00841	.02282	.03556	.05150
84.48	0	3.168	.00135	.00411	.00886	.02466	.03706	.05456
95.04	0	3.564	.00143	.00445	.00961	.02577	.03923	.05740
105.60	0	3.960	.00150	.00466	.00990	.02793	.04224	.06111
158.40	0	5.940	.00197	.00589	.01245	.03458	.05175	.07399
211.20	0	7.920	.00241	.00705	.01492	.04132	.06167	.08734
264.00	0	9.900	.00279	.00798	.01666	.04577	.07145	.1095
316.80	0	11.880	.00315	.00874	.01857	.05043	.07830	.1200
369.60	1	1.86	.00340	.00951	.01988	.05424	.08381	.1288
422.40	1	3.84	.00366	.01012	.02141	.05804	.08949	.1375
475.20	1	5.82	.00389	.01086	.02283	.06191	.09400	.1442
528.00	1	7.80	.00410	.01144	.02424	.06724	.10030	.1523
633.00	1	11.76	.00453	.01282	.02676	.07400	.1110	.1634
739.20	2	3.72	.00473	.01380	.02890	.08020	.1200	.1748
844.00	2	7.68	.00524	.01480	.03081	.08622	.1285	.1855
950.40	2	11.64	.00559	.01567	.03276	.09225	.1372	.1955
1056.00	3	3.60	.00589	.01656	.03458	.09692	.1450	.2047
1320.00	4	1.50	.00660	.01871	.03897	.1079	.1617	.2276
1584.00	4	11.40	.00732	.02064	.04316	.1187	.1773	.2483
2112.00	6	7.20	.00855	.02390	.04987	.1380	.2050	.2883
2640.00	8	3.00	.00966	.02705	.05648	.1550	.....	.....
3168.00	9	10.80	.01065	.03003	.06320	.....	.....	.....
3696.00	11	6.60	.01156	.03301	.06943	.....	.....	.....
4224.00	13	2.40	.01248	.03572	.....	.....	.....	.....
4752.00	14	10.20	.01338	.03786	.....	.....	.....	.....
5280.00	16	5.00	.01419	.....	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod. Ft.	In.	Diameters. 3 in. Cu. ft.	4 in. Cu. ft.	6 in. Cu. ft.	8 in. Cu. ft	10 in. Cu. ft.	11 in. Cu. ft.	12 in. Cu. ft.
5.280	0	0.198	.....	.....	.....	.....	.....	.....	1.265
6.336	0	0.238	.....	.....	.....	.....	.878	1.120	1.402
7.392	0	0.277	.....	.....	.....	.....	.960	1.221	1.489
8.448	0	0.317	.....	.....	.....	573	1.047	1.320	1.634
9.504	0	0.356	.....	.....	.....	611	1.110	1.394	1.728
10.560	0	0.396	.....	.....	.298	639	1.194	1.490	1.826
11.616	0	0.436	.....	.....	.314	659	1.205	1.580	1.940
12.672	0	0.475	.....	.....	.330	703	1.325	1.653	2.026
13.728	0	0.515	.....	.1235	.346	737	1.377	1.722	2.117
14.784	0	0.554	.....	.1298	.359	762	1.423	1.788	2.207
15.840	0	0.594	.0630	.1335	.377	808	1.470	1.854	2.297
18.480	0	0.684	.0692	.1465	.395	876	1.587	1.996	2.466
21.120	0	0.792	.0749	.1562	.444	931	1.683	2.136	2.662
26.400	0	0.990	.0839	.1771	.496	1.045	1.865	2.397	3.020
31.680	0	1.188	.0915	.1923	.548	1.575	2.059	2.636	3.310
36.960	0	1.386	.0992	.2146	.589	1.202	2.222	2.858	3.601
42.240	0	1.584	.1066	.2339	.631	1.344	2.383	3.062	3.856
47.520	0	1.782	.1119	.2460	.672	1.424	2.514	3.232	4.072
52.800	0	1.980	.1190	.2582	.721	1.496	2.662	3.419	4.305
63.360	0	2.376	.1313	.2893	.784	1.644	2.932	3.760	4.728
73.920	0	2.772	.1413	.3036	.858	1.782	3.210	4.016	5.094
84.480	0	3.168	.1507	.3237	.922	1.916	3.450	4.390	5.482
95.040	0	3.564	.1590	.3412	975	2.033	3.679	4.679	5.839
105.600	0	3.960	.1717	.3607	1.022	2.155	3.856	5.251	6.160
158.400	0	5.940	.2081	.4503	1.263	2.667	4.762	6.086	7.630
211.200	0	7.920	.2469	.5331	1.484	3.145	5.563	7.022	8.860
264.000	0	9.900	.2785	.5954	1.665	3.513	6.704	8.244	9.967
316.800	0	11.880	.3049	.6390	1.929	3.847	.....	.....	.....
369.600	1	1.860	.3331	.6967	1.976	4.196	.....	.....	.....
422.400	1	3.840	.3559	.7506	2.144	.....	.....	.....	.....
475.200	1	5.820	.3816	.7960	2.274	.....	.....	.....	.....
528.000	1	7.800	.4043	.9464	2.399	.....	.....	.....	.....
633.600	1	11.760	.4440	.9270	.....	.....	.....	.....	.....
739.200	2	3.720	.4977	1.0080	.....	.....	.....	.....	.....
844.800	2	7.680	.5131	1.0810	.....	.....	.....	.....	.....
950.400	2	11.640	.5436	.....	.....	.....	.....	.....	.....
1056.000	3	3.600	.5832	.....	.....	.....	.....	.....	.....
1320.000	4	1.500	.6523	.....	.....	.....	.....	.....	.....
1584.000	4	11.400	.....	.....	.....	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per M Feet.	Fall Per R. Ft	In.	Diameters. 14 in. Cu. ft.	15 in. Cu. ft.	16 in. Cu. ft.	18 in. Cu. ft.	20 in. Cu. ft.	22 in. Cu. ft.	24 in. Cu. ft.	27 in. Cu ft.
2.11	0	0.08	.....	.....	.....	.....	.....	.....	.....	.....
2.64	0	0.10	.....	.....	.....	.....	.....	.....	.....	8.27
3.17	0	0.12	.....	.....	.....	.....	3.61	4.61	6.10	8.87
3.70	0	0.14	.....	.....	2.25	3.10	4.07	5.25	6.04	9.09
4.22	0	0.16	1.71	2.05	2.43	3.27	4.35	5.62	7.13	9.48
4.75	0	0.18	1.83	2.19	2.59	3.49	4.68	6.01	7.56	10.26
5.28	0	0.20	1.91	2.30	2.72	3.66	4.92	6.32	7.95	10.74
5.81	0	0.22	2.02	2.43	2.88	3.88	5.15	6.62	8.34	11.45
6.34	0	0.24	2.11	2.54	3.02	4.06	5.40	6.94	8.75	11.93
6.86	0	0.26	2.18	2.65	3.18	4.23	5.62	7.24	9.14	12.54
7.39	0	0.28	2.27	2.75	3.28	4.40	5.82	7.51	9.47	12.96
7.92	0	0.30	2.35	2.84	3.39	4.61	6.05	7.78	9.80	13.49
8.45	0	0.32	2.44	2.94	3.49	4.75	6.27	8.03	10.13	13.98
8.98	0	0.34	2.54	2.98	3.62	4.90	6.48	8.36	10.57	14.41
9.50	0	0.36	2.59	3.11	3.69	5.03	6.65	8.55	10.77	14.81
10.03	0	0.38	2.67	3.21	3.81	5.17	6.92	8.85	11.10	15.21
10.56	0	0.40	2.72	3.29	3.92	5.30	7.05	9.07	11.43	15.63
11.62	0	0.44	2.88	3.47	4.12	5.63	7.42	9.55	12.05	16.44
12.67	0	0.48	3.02	3.63	4.32	5.87	7.79	10.01	12.61	17.23
13.73	0	0.51	3.15	3.79	4.51	6.18	8.14	10.48	13.23	18.01
14.78	0	0.55	3.29	3.95	4.68	6.38	8.48	10.91	13.79	18.75
15.84	0	0.59	3.42	4.11	4.87	6.64	8.77	11.29	14.25	19.50
18.48	0	0.69	3.62	4.46	5.31	7.17	9.49	12.25	15.50	21.13
21.12	0	0.79	3.99	4.78	5.67	7.65	10.16	13.12	16.62	22.62
26.40	0	0.99	4.46	5.37	6.39	8.66	11.43	14.78	18.71	25.34
31.68	0	1.19	4.91	5.91	7.02	9.54	12.59	16.20	20.42	27.74
36.96	0	1.39	5.37	6.45	7.66	10.33	13.66	17.53	22.05	29.96
42.24	0	1.59	5.77	6.90	8.16	11.09	14.66	18.78	23.61	31.90
47.52	0	1.78	6.11	7.31	8.64	11.71	15.54	19.93	25.07	33.97
52.80	0	1.98	6 44	7.70	9.10	12.37	16.47	21.06	26.42	35.89
63.36	0	2.38	7.00	8.39	9.95	13.65	17.99	23.07	29.03	39.76
73.92	0	2.77	7.60	9.15	10.87	14.75	19.49	24.68	31.49	43.22
84.48	0	3.17	8.17	9.81	11.63	15.84	21.03	26.97	33.90	46.57
95.04	0	3.56	8.93	10.47	12.43	16.90	22.45	29.70	36.18	48.06
105.60	0	3.96	9.26	11.09	13.14	17.85	23.56	31.15	38.45	.....
158.40	0	5.94	11.39	13.66	16.17	21.86	28.86	.....	.....	.....
211.20	0	7.92	13.22	15.84	18.77	.....	.....	.....	.....	.....

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TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod Ft.	Fall Per Rod In.	Diameters. 30 in. Cu. ft.	33 in. Cu. ft.	36 in. Cu. ft.	40 in. Cu. ft.	44 in. Cu. ft.	48 in. Cu. ft.
1.06	0	0.04	.....	.....	10.29	13.88	18.15	22.98
1.58	0	0.06	7.78	10.21	12.70	17.00	22.22	27.89
2.11	0	0.08	8.99	11.65	14.56	19.68	25.55	32.93
2.64	0	0.10	10.24	12.92	16.35	22.08	28.87	37.00
3.17	0	0.12	10.97	13.99	18.02	24.43	31.46	40.21
3.70	0	0.14	11.90	15.14	19.76	26.27	34.47	43.67
4.22	0	0.16	12.84	16.36	20.85	28.14	37.05	46.81
4.75	0	0.18	13.48	17.58	22.30	29.80	39.01	49.06
5.28	0	0.20	14.21	18.74	23.47	31.46	41.06	52.15
5.81	0	0.22	15.05	19.54	24.91	33.25	42.09	54.95
6.34	0	0.24	15.81	20.28	26.12	34 68	44.97	57.36
6.86	0	0.26	16.47	21.29	27.20	36.21	46 77	60.07
7.39	0	0.28	17.18	22.20	28.24	37.57	48.83	62.02
7.92	0	0.30	17 94	23.01	29.19	39 18	50.62	64.47
8.45	0	0.32	18.58	23.76	30.29	40.54	52.46	66.53
8.98	0	0.34	19.21	24.47	31.42	41.88	54.04	68.50
9.50	0	0.36	19.66	25.22	32.48	43.07	55.48	70.62
10.03	0	0.38	20.32	26.14	33.40	44.28	57.01	72.75
10.56	0	0.40	20.79	26.94	34.49	45.20	58.85	74.44
11.62	0	0.44	21.80	28.27	36.15	48.12	61.71	78.29
12.67	0	0.48	22.83	29.02	37.74	50.48	64.35	81.68
13.73	0	0.51	23.93	31.06	39.40	52.67	66.87	85.20
14.78	0	0.55	24.86	32.28	40.86	55.04	69.57	88.46
15.84	0	0.59	25.87	33.62	42.28	56.33	72.32	91.73
18.48	0	0.69	27.96	36.17	45.95	61.09	77.95	100.40
21.12	0	0.79	29.84	38.57	48.83	65.41	83.60	106.89
26.40	0	0.99	33.55	43.12	54.89	73.09	93.37	119.34
31.68	0	1.19	36.79	47.40	59.95	80.32	103.28	130.88
36.96	0	1.39	39.66	51.35	65.17	86.70	111.74	142.09
42.24	0	1.59	42.39	54.91	69.80	92.58	119.93	153.94
47.52	0	1.78	45.23	58.20	74.33	98.00	128.26	.....
52.80	0	1.98	47.71	61.62	78.46	103.99	.....	.....
63.36	0	2.38	52.91	68.00	82.84	.....	.....	.....
78.92	0	2 77	57.65	73 95	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod. Ft.	Fall Per Rod. In.	Diameters. 54 in. Cu. ft.	60 in. Cu. ft.	72 in. Cu. ft.	84 in. Cu. ft.	96 in. Cu. ft.
.53	0	0.02	21.96	29.77	46.99	75.43	107.77
1.06	0	0.04	31.70	38.19	57.65	104.61	152.45
1.58	0	0.06	38.53	52.09	82.53	126.18	188.45
2.11	0	0.08	45.12	59.04	95.99	145.43	218.75
2.64	0	0.10	50.23	67.56	109.42	162.75	245.30
3.17	0	0.12	55.51	74.32	121.58	177.03	267.41
3.70	0	0.14	60.21	80.51	132.04	192.04	290.53
4.22	0	0.16	63.61	86.30	139.96	207.81	310.89
4.75	0	0.18	67.20	91.99	148.72	222.44	324.20
5.28	0	0.20	72.37	96.98	157.77	235.13	350.45
5.81	0	0.22	75.71	102.39	165.97	253.34	366.19
6.34	0	0.24	79.13	107.31	173.04	264.77	382.02
6.86	0	0.26	82.54	115.53	179.26	275.16	397.85
7.39	0	0.28	85.90	116.53	187.46	287.67	414.70
7.92	0	0.30	89.52	119.63	193.93	296.37	427.76
8.45	0	0.32	92.43	123.70	200.13	307.87	443.09
8.98	0	0.34	95.35	127.63	206.40	316.15	457.42
9.50	0	0.36	97.65	131.26	212.05	326.73	470.49
10.03	0	0.38	100.19	134.79	217.71	336.79	481.53
10.56	0	0.40	103.82	138.84	225.21	348.25	496.37
11.62	0	0.44	108.78	145.98	235.52	364.92	522.76
12.67	0	0.48	113.47	152.50	246.41	380.09	547.88
13.73	0	0.51	118.48	158.65	256.17	394.48	570.01
14.78	0	0.55	123.10	164.54	267.19	408.36	592.13
15.84	0	0.59	128.19	170.43	277.88	423.36	612.00
18.48	0	0.69	138.92	183.93	299.72	462.99	.....
21.12	0	0.79	147 91	197.52	320.74	.....	.....
26.40	0	0.99	165.80	221.95	358.52	.....	.....
31.68	0	1.19	182.42	244.26	.....	.....	.....
36.96	0	1.39	190.01	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND OVER WEIRS, FOR EACH FOOT IN LENGTH OF WEIR.

Head from Still water Ft.	In.	Flow per S 1 ft. in lgt. Cu. Ft.	Head from Still water Ft.	In.	Flow per S 1 ft. in lgt. Cu. Ft.	Head from Still water Ft.	In.	Flow per S 1 ft. in lgt. Cu. Ft.
0	0.48	.026	0	5.52	1.039	1	2.4	4.390
0	0.60	.037	0	5.76	1.107	1	3.6	4.951
0	0.72	.048	0	6.00	1.177	1	4.8	5.531
0	0.84	.060	0	6.24	1.248	1	6.0	6 134
0	0.96	.074	0	6.48	1.321	1	7.2	6.756
0	1.08	.088	0	6.72	1.396	1	8.4	7.399
0	1.20	.104	0	6.96	1.472	1	9.6	8.062
0	1.32	.120	0	7.20	1.551	1	10.8	8.732
0	1.44	.137	0	7.44	1.629	2	0.0	9.430
0	1.56	.154	0	7.68	1.708	2	1.2	10.146
0	1.68	.172	0	7.92	1.789	2	2.4	10.869
0	1.80	.191	0	8.16	1.871	2	3.6	11.619
0	1.92	.210	0	8.40	1.960	2	4.8	12.385
0	2.04	.230	0	8.64	2.038	2	6.0	13 167
0	2.16	.251	0	8.88	2.124	2	7.2	13.965
0	2.28	.273	0	9.12	2.212	2	8.4	14.778
0	2.40	.295	0	9.36	2.300	2	9.6	15.607
0	2.64	.341	0	9.60	2.388	2	10.8	16.450
0	2.88	.388	0	9.84	2.479	3	0.0	17.309
0	3.12	.438	0	10.08	2.570	3	1.2	18.181
0	3.36	.489	0	10.32	2.662	3	2.9	19 068
0	3.60	.545	0	10.56	2.756	3	3.6	19.969
0	3.84	.598	0	10.80	2.850	3	4.8	20.795
0	4.08	.657	0	11.04	2.946	3	6.0	21.719
0	4.32	.716	0	11.28	3 043	3	7 2	22 657
0	4.56	.776	0	11 52	3 141	3	8.4	23.607
0	4.80	.838	0	11.76	3.240	3	9.6	24 571
0	5.04	.902	1	0.00	3.339	3	10 8	25.547
0	5.28	.972	1	1.20	3.852	4	0.0	26 536

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TABLE SHOWING FLOW OF WATER IN OPEN CHANNELS—

BASE TO PERPENDICULAR OF THE SIDE SLOPES BEING AS 3 : 4.

Fall per M'l. Ft.	Fall per Rod. In.	T 2.2 ft. B 1.0 ft D .8 ft Section 1.28 sq. ft. Cu. ft.	T 3.3 ft. B 1.5 ft D 1.2 ft Section 2.88 sq. ft. Cu. ft.	T 4.4 ft B 2.0 ft D 1.6 ft Section 5.12 sq. ft. Cu. ft.	T 5.5 ft B 2.5 ft D 2.0 ft Section 8.0 sq. ft. Cu. ft.	T 6.6 ft B 3.0 ft D 2.4 ft Section 11.52 sq. ft. Cu. ft.	T 7.7 ft B 3.5 ft D 2.8 ft Section 15.68 sq. ft. Cu. ft.	T 8.8 ft B 4.0 ft D 3.2 ft Section 20.48 sq. ft. Cu. ft.
1	.0375	.45	1.33	2.67	5.57	9.05	13.46	20.26
2	.0750	.63	1 88	3.87	7.88	12.80	19.04	28.64
3	.1125	.77	2.30	4.74	9.65	15.67	23.32	35.08
4	.1500	.89	2.65	5.47	11.14	18.52	26.93	40.51
5	.1875	1.00	2.97	6.12	12.46	20.24	30.11	45.30
6	.2250	1.09	3.25	6.70	13.65	22.17	32.98	49.62
7	.2625	1.18	3.42	7.24	14.74	23.94	35.63	53.58
8	.3000	1.26	3.75	7.73	15.75	25.60	38.08	57.28
9	.3375	1.34	3.98	8.21	16.71	27.15	40.39	60.76
10	.3750	1.41	4.19	8.65	17.61	28.62	42.57	64.06
11	.4125	1.48	4.40	9.07	18.47	30.02	44.65	67.18
12	.4500	1.54	4.60	9.48	19.30	31.35	46.64	70.05
13	.4875	1.61	4.78	9.86	20.08	32.63	48.54	73.03
14	.5250	1.67	4.96	10.24	20.84	33.87	50.38	75.79
15	.5625	1.73	5.14	10.60	21.57	35.06	52.14	78.44
16	.6000	1.78	5.31	10.94	22 27	36.20	53 86	81.09
17	.6375	1.84	5.47	11.28	22.96	37.31	55.51	83.54
18	.6750	1.89	5.63	11.60	23.63	38.39	57 11	85.93
19	.7125	1.94	5.78	11 92	24.28	39.44	58.58	88.29
20	.7500	1.99	5.93	12.23	24.91	40.47	60.21	90.58
21	.7875	2.04	6.08	12.54	25.53	41.47	61.70	92.82
22	.8250	2.09	6.22	12.83	26.12	42.45	63.15	95.00
23	.8625	2.14	6.36	13.12	26.71	43.40	64.57	97.15
24	.9000	2.18	6.50	13.40	27.29	44.34	65.95	99.23
25	.9375	2.23	6.63	13.68	27.98	45.24	67.32	101.28

In Tables, T signifies top width ; B, bottom width ; D, depth.

TABLE SHOWING FLOW OF WATER IN OPEN CHANNELS—

BASE TO PERPENDICULAR OF THE SIDE SLOPES BEING AS 3 · 4.

Fall per M'l. F.	Fall per Rod. In.	T 9.9 ft B 4.5 ft D 3.6 ft Section 25.92 sq. ft. Cu. ft.	T 11. ft B 5. ft D 4. ft Section 32. sq. ft. Cu. ft.	T 13.2 ft B 6.0 ft D 4.8 ft Section 46.09 sq. ft. Cu. ft	T 16.4 ft B 7 0 ft D 5.6 ft Section 62.72 sq. ft. Cu. ft	T 17.6 ft B 8.0 ft D 6.4 ft Section 81.92. sq. ft Cu. ft.	T 19.8 ft B 9.0 ft D 7.2 ft Section 103.68 sq. ft. Cu. ft.	T 22. ft B 10. ft D 8. ft Section 128. sq. ft Cu. ft
1	.0375	28.04	37.1	58.4	96.5	138.3	189.2	261.2
2	.0750	39.67	52.4	82.7	136.4	196.7	267.6	369.4
3	.1125	48.59	64.2	101.4	167.1	239.6	327.7	451.3
4	.1500	56.10	74.1	117.1	192.9	276.7	378.4	522.3
5	.1875	62.71	82 9	130.9	215 7	309.3	423.1	584.0
6	.2250	68.70	90.8	143.4	236.3	338.8	463.5	639.8
7	.2625	74.19	98.1	154.8	255.3	366.0	500.5	691.0
8	.3000	79.53	104.8	165.5	272.9	391.2	535.1	738.7
9	.3375	84.14	111.1	175.6	289.4	415.0	567.6	783.5
10	.3750	88.68	117.1	185.1	305.0	437.4	598.2	825.9
11	.4125	93.02	122.9	194.1	319.9	458.7	613.2	866.2
12	.4500	97.15	128.4	202.8	334.2	479.1	655.4	925.6
13	.4875	101.13	133.6	211.1	347.8	498.7	682.1	941.7
14	.5250	104.94	138.7	219.0	360.9	517.5	707.8	977.2
15	.5625	108.63	143.5	226.6	373.6	535.7	732.8	1011.5
16	.6000	112.18	148.2	234.1	385.9	553.3	756.7	1044.7
17	.6375	115.64	152.4	241.3	397.8	570.3	780.1	1076.9
18	.6750	118.99	157.2	248.3	409.3	586.9	802.7	1108.1
19	.7125	122.26	161.5	255.1	420.5	601.5	824.8	1138.4
20	.7500	125.43	165.7	261.7	431.4	618.5	846.1	1168.0
21	.7875	128 53	169.8	268.2	442.0	633.9	867.0	1196.8
22	.8250	131.55	173.8	274.5	452.5	648.8	887.4	1225 0
23	.8625	134.51	177.7	280.7	462.9	663.4	907.4	1252.6
24	.9000	137.40	181.5	286.7	472.6	677.7	926.0	1279.5
25	.9375	140.24	185.3	292.6	482.3	691.6	946.0	1306.0

In Tables, T signifies top width ; B, bottom width ; D, depth.

TABLE SHOWING FLOW OF WATER IN OPEN CHANNELS—

BASE TO PERPENDICULAR OF THE SIDE SLOPES BEING AS 2 : 1.

Fall per Mile. Feet.	Fall per Rod. Inches.	T 6. ft B 2. ft D 1. ft Section 4. sq. ft. Cu. ft.	T 9. ft B 3. ft D 1.5 ft Section 9. sq. ft. Cu. ft.	T 12. ft B 4. ft D 2. ft Section 16. sq. ft. Cu. ft.	T 16. ft B 6. ft D 2.5 ft Section 27.5 sq. ft. Cu. ft.	T 22. ft B 10. ft D 3. ft Section 48. sq. ft. Cu. ft.	T 28. ft B 12. ft D 4. ft Section 80. sq. ft. Cu. ft.	T 40. ft B 20. ft D 5. ft Section 150. sq. ft. Cu. ft.
.5	.01875	1.27	3.85	8.63	18.11	8.79	78.2	188.1
.6667	.0250	1.46	4.44	9.96	20.91	44.79	90.3	217.2
.8333	.03125	1.63	4.96	11.14	23.38	50.08	101.0	242.8
1.	.0375	1.79	5.44	12.20	25.61	54.86	110.6	266.0
1.25	.046875	2.00	6.08	13.64	28.68	61.32	123.7	297.4
1.5	.05625	2.19	6.67	14.96	21.34	67.26	135.7	326.1
1.75	.065625	2.37	7.19	16.14	33.88	72.57	146.4	351.8
2.	.0750	2.53	7.69	17.26	36.22	77.58	156.5	376.1
2.25	.084375	2.68	8.16	18.30	38.42	82.29	165 9	399.0
2.5	.09375	2.83	8.60	19.29	40.50	86.72	174.9	420.6
3.	.1125	3.10	9.42	21.14	44.36	95.00	191.6	460.7
3.5	.13125	3.35	10.17	22.83	47.91	102.6	207.0	497.6
4.	.1500	3.58	10.87	24.41	51.22	109.7	221.3	531.9
4.5	.16875	3.79	11.54	25.88	54.33	116.3	234.7	564.2
5.	.1875	4.00	12.16	27.29	57.27	122.7	247.4	594.8
6.	.2250	4.38	13.31	29.89	62.74	134.4	271.0	651.5
7.	.2625	4.73	14.39	32.29	67.79	145.1	292.7	703.6
8.	.3000	5.06	15.38	34.52	72.43	155.2	312.9	752.2
9.	.3375	5.37	16.31	36.61	76.83	164.6	331.9	797.9
10.	.3750	5.66	17 19	38.59	80.99	173.5	349.9	841.1
11.	.4125	5.93	18.03	40.47	84.94	181.9	366.9	882.1
12.	.4500	6.20	18.74	42.27	88.72	190.1	383.2	921.5

In Tables, T signifies top width ; B, bottom width, D, depth

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TABLE SHOWING ADDITIONAL HEAD REQUIRED TO OVERCOME THE RESISTANCE OF ONE CIRCULAR BEND.

Velocity per Sec. Feet.	Ratio of Radius of Pipe to Radius of Bend. 1 : 5 30° Head. Feet.	1 : 5 60 Head. Feet.	1 : 5 90° Head. Feet.	1 : 5 120° Head. Feet.	1 : 5 180° Head. Feet.	2 : 5 30° Head. Feet.	2 : 5 90° Head. Feet.	2 : 5 120° Head. Feet.	2 : 5 180° Head. Feet.
1	.0004	.0007	.0011	.0014	.0022	.0005	.001	.002	.002
2	.0014	.0029	.0043	.0058	.0086	.0021	.004	.006	.008
3	.0032	.0064	.0096	.0128	.0192	.0048	.010	.014	.020
4	.0057	.0114	.0171	.0228	.0342	.0085	.017	.025	.034
5	.0089	.0179	.0268	.0358	.0536	.0133	.027	.040	.054
6	.0129	.0257	.0386	.0514	.0772	.0192	.038	.052	.076
7	.0175	.0350	.0525	.0700	.1050	.0261	.052	.078	.104
8	.0229	.0457	.0686	.0914	.1372	.0341	.068	.102	.136
10	.0357	.0714	.1072	.1428	.2144	.0533	.107	.160	.214
15	.0804	.1607	.2411	.3214	.4822	.1200	.240	.360	.480
20	.1429	.2858	.4287	.5716	.8574	.2130	.426	.639	.852
25	.2232	.4464	.6696	.8928	1.34	.3333	.667	1.00	1.33
30	.3214	.6428	.9642	1.29	1.93	.4798	.960	1.44	1.92
40	.5714	1.14	1.71	2.28	3.42	.8530	1.71	2.56	3.42
50	.8927	1.79	2.68	3.58	5.36	1.333	2.66	3.99	5.32
75	2.01	4.02	6.03	8.04	12.06	3.00	6.00	9.00	12.00
100	3.57	7.14	10.71	14.28	21.42	5.33	10.67	15.99	21.34
150	8.04	16.07	24.11	32.14	48.22	12.00	24.00	36.00	48.00
200	14.29	28.58	42.87	57.16	85.74	21.32	42.64	63.96	85.28
300	32.14	64.28	96.42	128.56	192.84	47.98	95.96	143.94	191.92

TABLE SHOWING ADDITIONAL HEAD REQUIRED TO OVERCOME THE RESISTANCE OF ONE ANGULAR BEND.

Velocity Per Sec. Feet.	Angles of Deflection. 15° Head. Feet.	30° Head. Feet.	40° Head. Feet.	60° Head. Feet.	90° Head. Feet.	120° Head. Feet.
1	.0002	.0005	.002	.006	.015	.029
2	.0010	.0019	.009	.023	.061	.116
3	.0022	.0042	.019	.051	.138	.260
4	.004	.008	.035	.090	.245	.462
5	.006	.012	.054	.141	.382	.723
6	.009	.017	.078	.204	.550	1.04
7	.012	.023	.106	.277	.749	1.42
8	.016	.030	.138	.362	.978	1.85
10	.025	.047	.216	.565	1.53	2.89
15	.056	.105	.486	1.27	3.44	6.50
20	.099	.186	.863	2.26	4.85	11.56
25	155	.291	1.35	4.45	9.55	18.06
30	.224	.419	1.94	5.09	13.75	26.01
40	.398	.745	3.45	9.04	24.45	46.23
50	.621	1.17	5.40	14.13	38.20	72.93
75	1.40	2.62	12.14	31.79	85.95	162.5
100	2.48	4.66	21.58	56.52	152.8	289 0
150	5.59	10.48	48.57	127.2	343.7	650.2
200	9.94	18.63	86.32	226.1	611.1	1156
300	22.36	41.92	194.2	508.7	1375.	2601.

TABLE SHOWING FLOW OF WATER THROUGH RECTANGULAR ORIFICES IN THIN VERTICAL PARTITIONS.

Head upon center of orifice. feet.	Velocity per second. feet.	Breadth and Height of Orifice. 1 ft. High. 1 ft. Wide		9 in. High. 1 ft. Wide.		6 in. High. 1 ft. Wide.		3 in. High. 1 ft. Wide.		1.5 in. High 1 ft. Wide.	
		cu ft.	H. P.	cu ft.	H. P	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
0.2	3.58	....	....	....	....	....	....	....	....	.028	.0064
.3	4.40	....	....	....	....	....	....	0 69	.022	.34	.010
.4	5.07	....	....	....	....	1 56	.071	.80	.036	.40	.018
.5	5.67	....	....	2.57	.146	1.74	.099	.89	.051	.45	.026
.6	6.22	3.72	.253	2.83	.193	1.91	.130	.98	.066	.49	.033
.7	6.72	4.02	.317	3.06	.249	2.07	.165	1.06	.082	.53	.041
.8	6.38	4.31	.392	3.27	.297	2.21	.201	1.14	.104	.57	.052
.9	7.62	4.57	.467	3.48	.356	2.35	.240	1.20	.122	.60	.061
1.0	8.025	4.87	.554	3.67	.417	2.48	.281	1.26	.144	.63	.072
1.25	8.99	5.29	.751	4.02	.571	2.71	.385	1.39	.197	.69	.098
1.50	9.83	5.92	1.01	4.50	.767	3.03	.517	1.55	.259	.77	.129
1.75	10.59	6.40	1.27	4.86	.967	3.27	.650	1.67	.326	.83	.163
2.00	11.35	6.85	1.56	5.20	1 18	3.50	.795	1 79	.398	.89	.199
2.25	12.00	7.27	1.86	5.51	1 41	3.71	.949	1.89	475	.95	.237
2.50	12.68	7.67	2.18	5.81	1 65	3.91	1.11	1.99	.565	1.00	.283
2.75	13.32	8.05	2.53	6.09	1 86	4.10	1.28	2.09	.654	1.04	.327
3.00	13.99	8.41	2.8	6 36	2 17	4.27	1.46	2 18	.743	1 09	.371
3.50	15.01	9.08	3.61	6.86	2 73	4.61	1.83	2 35	.935	1.17	.467
4.00	16.05	9.97	4.54	7.32	3 33	4.92	2.24	2.50	1 14	1 25	.568
4.50	17.02	10.29	5.26	7.75	3.96	5.21	2.66	2.65	1 36	1 32	.678
5.00	17.95	10.84	6.16	8.16	4.64	5.49	3.12	2.78	1 58	1 39	.781
6.	19.66	11.84	8.08	8.91	6.08	5.98	4.08	3.03	2 07	1.51	1.03
7.	21.23	12.76	10.14	9.61	7.64	6.43	5.12	3 24	2 58	1.62	1.29
8.	22.71	13.64	12.40	10.25	9.32	6.84	6 22	3.45	3 14	1.71	1.50
9.	24.70	14.47	14.80	10.86	11.11	7.25	7 42	3.64	3 72	1.83	1.82
10.	25.38	15.25	17.34	11.44	13.00	7.62	8 66	3.83	4 34	1.92	2.18
15.	31.08	18.68	31.85	14.01	23.88	9.34	15 93	4.69	8.00	2.36	4.02
20.	35.89	21.50	49.05	16.18	36.78	10.8	24 55	5.42	12.29	2.72	6.15
25.	40.13	24.12	68.52	18.10	51 42	12.08	34.32	6.06	17.22	3.05	8.67
30.	43.96	26.43	90.10	19.84	67.64	13 47	45.92	6 64	22 64	3.35	11.42
35.	47.47	28.56	113.6	21.44	85.27	14.31	56.96	7.18	28.56	3.62	14.40
40.	50.75	30.53	138.8	22.94	104.3	15.32	69 64	7.68	34.91	3.79	17.23
45.	53.83	32.39	165.6	24.35	124.5	16 26	83.14	8 16	41.73	4.12	21.02
50	56.75	34.15	194.0	25.68	145 8	17.16	97 50	8 61	48.92	4.35	24.72

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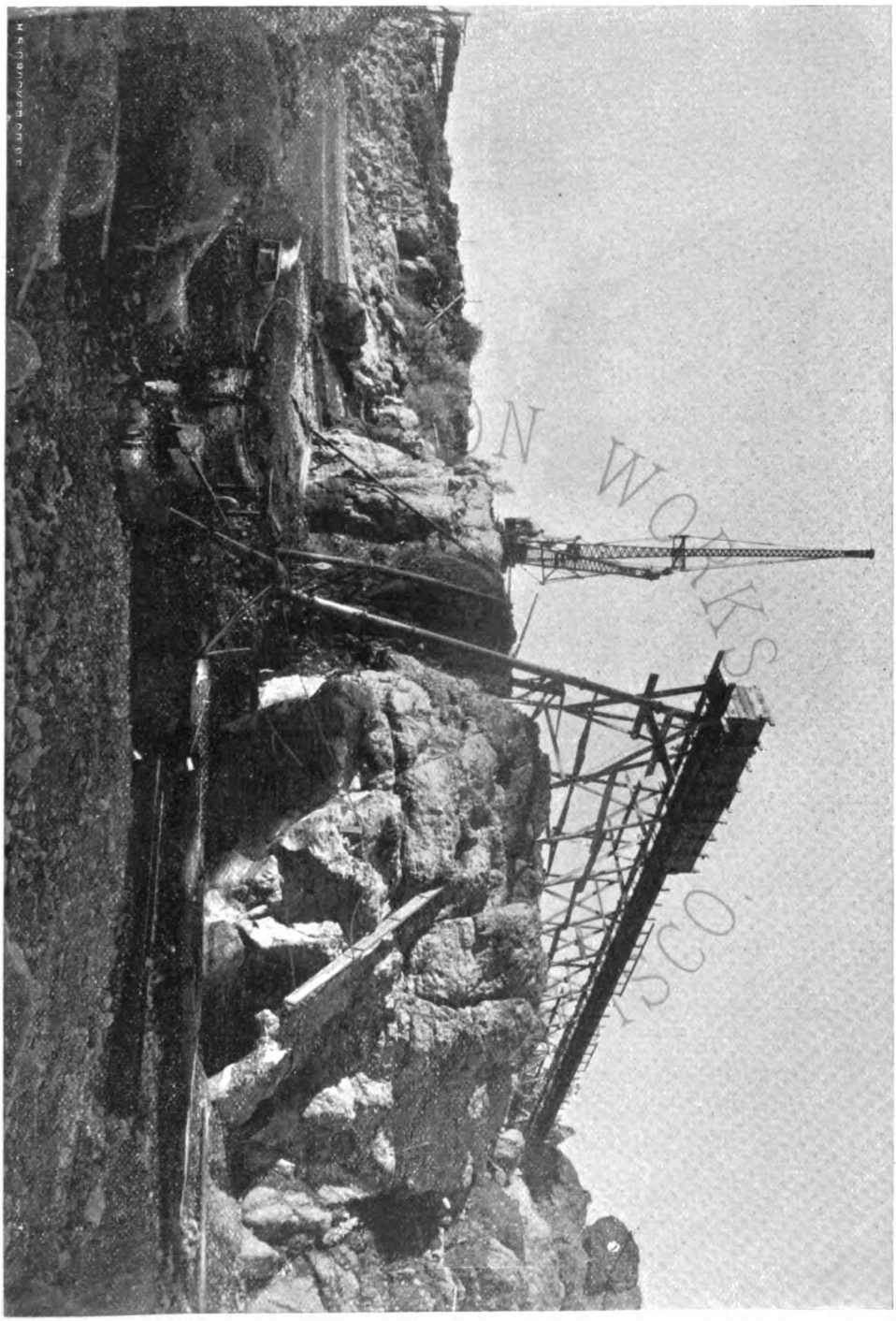


PLATE No. 20.

EVANS HYDRAULIC ELEVATOR,

FEATHER RIVER.

HEAD, 400 FEET. LIFT, 72 FEET. SHOWING STEEL DERRICK.

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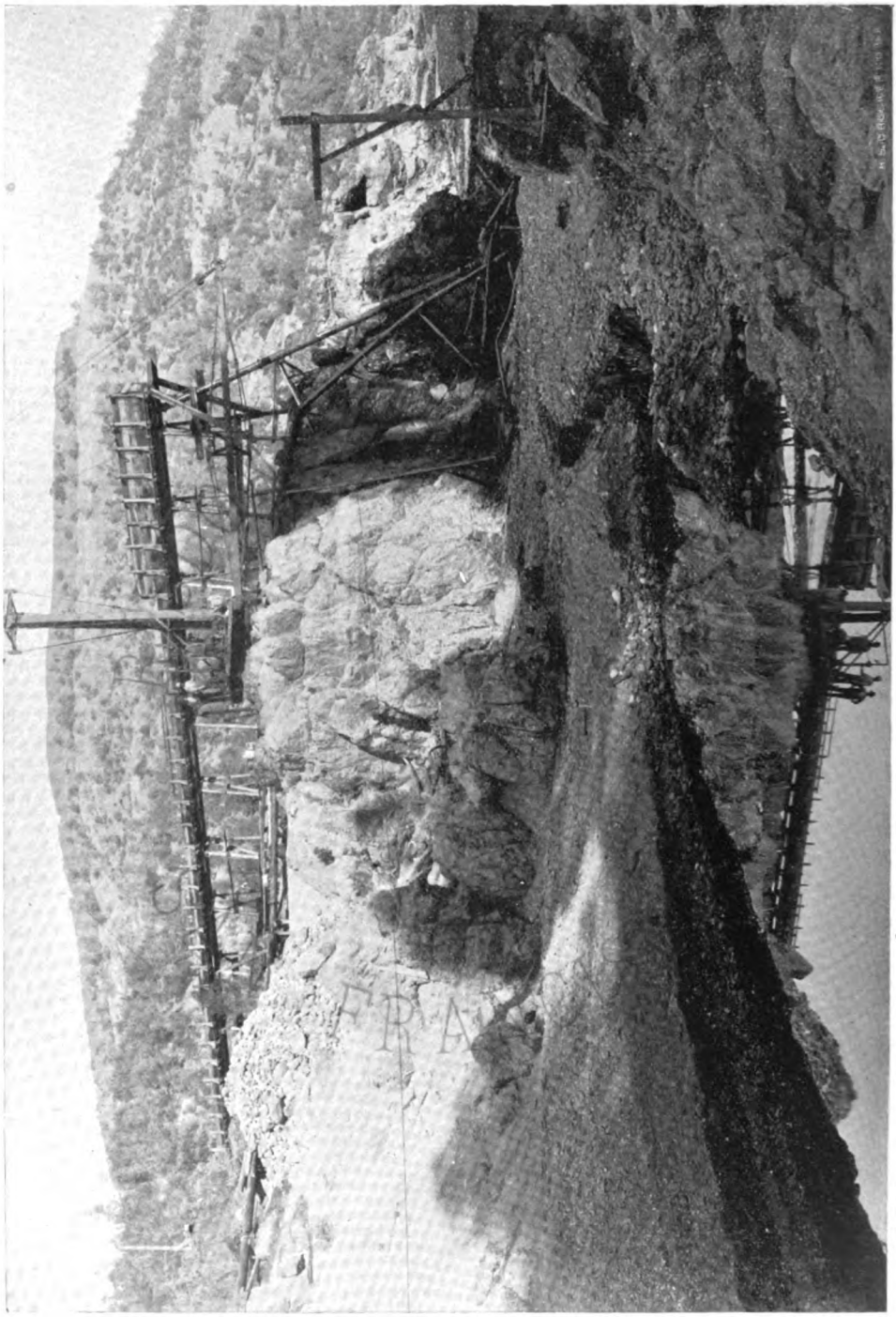


PLATE No. 21.

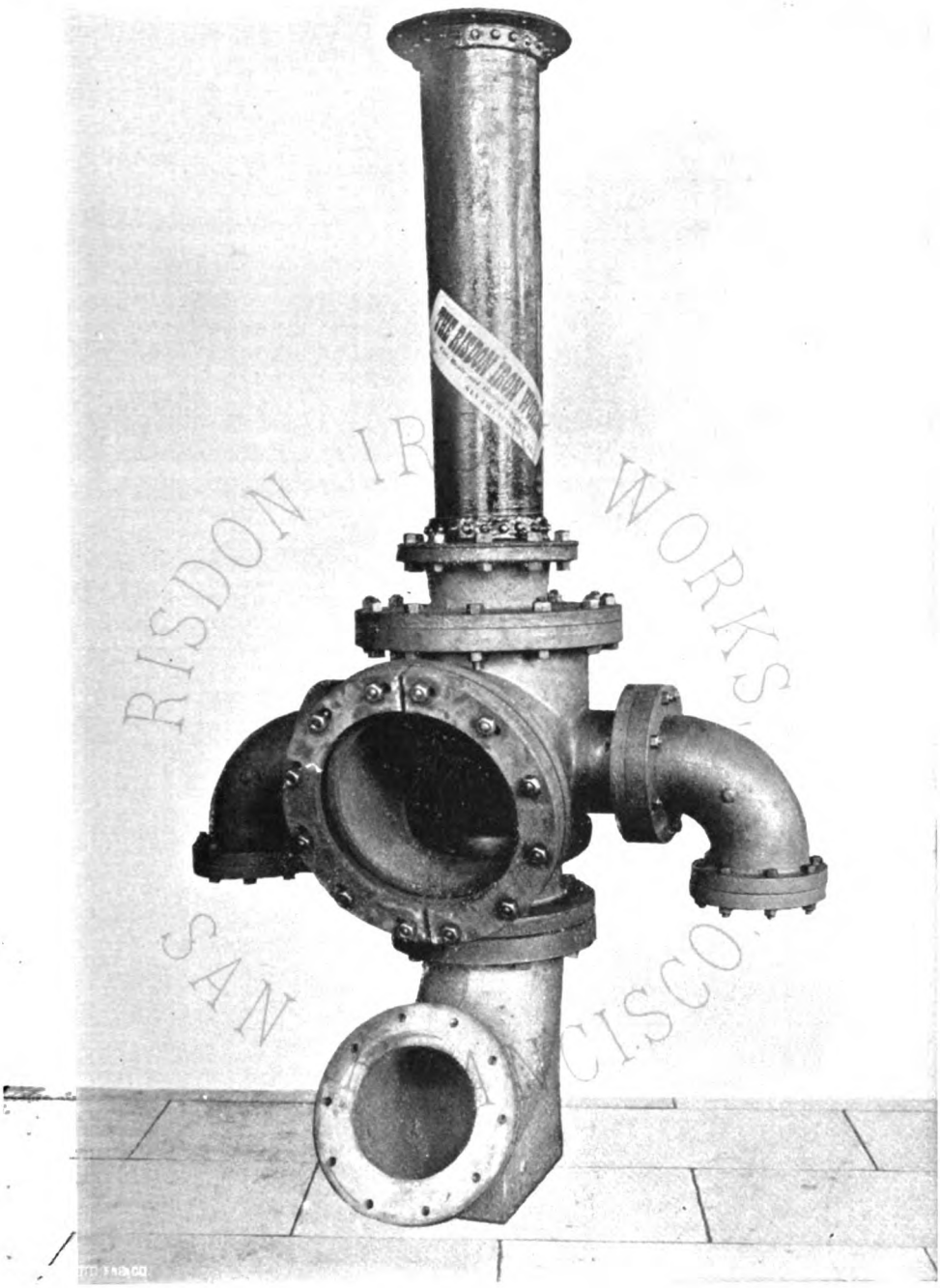
EVANS HYDRAULIC ELEVATOR,

FEATHER RIVER.

SAME AS PLATE NO. 20, LOOKING IN OPPOSITE DIRECTION.

THE
JOHN CRERAR
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RISDON IRON WORKS SAN FRANCISCO

PLATE No. 22.

EVANS HYDRAULIC ELEVATOR.

The above cut is from a photograph of our latest style of Elevator. Its construction is clearly shown. The throat casting is of steel, and the throat is brought down as closely as possible to the jet, thus insuring the highest efficiency of the jet.

The discharge pipe, bolted to the top of throat casting, is of heavy steel plate with all rivet heads countersunk.

The advantages of this general design and construction are apparent.

HYDRAULICS

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TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head. Feet.	Velocity pr sec. Feet.	50 M inch. 1 cu ft H. P.	100 M inch. 2 cu ft H. P.	Diameters of Nozzles. 1 inch		1.5 inches.		2 inches.		2.5 inches.	
				cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
1	8.025	.106	.212	.041	.0046	.093	.010	.164	.018	.255	.029
1.5	9.83	.158	.316	.050	.0085	.111	.019	.200	.034	.312	.053
2	11.35	.211	422	.058	.013	.130	.029	.232	.052	.360	.082
2.5	12.68	.264	.528	.064	.018	.145	.041	.256	.072	.402	.114
3	13.90	.317	.634	.061	.024	.159	.054	.284	.096	.440	.150
3.5	15 01	.370	.740	.016	.030	.171	.068	.304	.120	4 5	189
4	16.05	.421	.842	.081	.03	.183	.083	.324	.148	.507	.231
4 5	17 02	.474	.948	.086	.044	.194	.099	.344	.176	.540	.275
5	17 95	.528	1 06	.091	.051	.205	.113	.364	.204	.56	.315
6	19.66	.634	1.27	.100	.068	.224	.153	.400	.272	.622	.425
7	21.23	.739	1.48	.108	.086	.242	.193	.432	.344	672	.535
7 5	21.98	.702	1.58	.111	.095	.250	.214	.444	.380	.697	.595
10	25.38	1.06	2.12	.129	.146	.290	.329	.516	.584	.805	.915
12.5	28.37	1.32	2.64	.144	204	.324	.46	5 6	.816	897	1.28
15	31.08	1.59	3.18	.158	.269	.355	.505	.632	1.08	.985	1 66
17.5	33 57	1.85	3.70	.170	.339	.383	.782	.680	1.36	1.06	2.11
20	35 89	2.11	4.22	.182	.414	.410	.931	.728	1.66	1 14	2.58
22.5	38 07	2.38	4.76	.193	.494	.435	1.11	.772	1.98	1.21	3.08
25	40 13	2.64	5.28	.204	578	.458	1.30	816	2.31	1.27	3.61
27.5	42 08	2.90	5.80	.213	66	480	1.50	.852	2.6	1.33	4.17
30	43.95	3.02	6 04	.228	760	.513	1 71	.912	3.04	1.42	4.75
32.5	45.75	3.34	6.68	.232	857	.522	1.93	.928	3.43	1.45	5.35
35	47.47	3.69	7.38	.241	.958	.542	2.15	.964	3.83	1.51	5.98
40	50.75	4.22	8.44	.257	1.17	.579	2.63	1.03	4.68	1.61	7.31
45	53.83	4.75	9.50	.273	1.40	.614	3.14	1.09	5.60	1 71	8.23
50	56.75	5.28	10.56	.288	1.64	.648	3.68	1.15	6.56	1.79	10.22
60	62.16	6 34	12.68	.385	2.15	.709	4.84	1.26	8.60	1.97	13.43
70	67.14	7.39	14.78	.341	2.71	.766	6.10	1.36	10.84	2.13	16.93
80	71.78	8.46	16.90	.364	3.31	.819	7.45	1.46	13.24	2.27	20.69
90	76.13	9.53	19.06	.386	3.95	.864	8.88	1.54	15.80	2.44	24.68
100	80.25	10.56	21.12	.407	4.63	.916	10.41	1.63	18.52	2.54	28.90
125	89.72	13.21	26.42	.455	6.47	1.02	14.55	1.82	25 88	2.81	40.40
150	98.28	15.85	31.70	.499	8.50	1.12	19.12	2.00	34.00	3.11	53.13
175	106.1	18.50	37.00	.539	10.70	1.21	24.07	2.16	42.80	3.36	66 86
200	113.5	21.14	42.28	.576	13.1	1.29	29.43	2.30	52.4	3.50	81.76
250	127.1	26.62	52.84	.644	18.3	1.45	41.13	2.58	73.2	4.02	114.2
300	139.0	31.70	63.40	.705	24.0	1.59	54.07	2.82	96.0	4.40	150.2
350	150.1	37.08	74.16	.762	30.3	1.71	68.15	3.05	121.2	4.76	189.3
400	160.5	42.27	84.54	.814	37.0	1.83	83.25	3.26	148.0	5.09	231.2
450	170.2	47.64	95.28	.864	44.2	1.94	99.34	3.46	176.8	5.40	276.0
500	179.4	52.84	105.7	.910	51.7	2.05	116.5	3.64	206.8	5.60	323.2
550	188.2	58.22	116.4	.955	59.7	2.10	134.2	3.82	238.8	5.96	372.7
600	196.6	63.41	126.8	.990	68.0	2.23	152.9	3.99	272.0	6.23	475.0
700	212.3	73.98	148.0	1.06	85.7	2.46	192.8	4.36	342.8	6.79	535.5
800	226.9	84.55	169.1	1.15	104.7	2.58	235.5	4.60	418.8	7.19	654.0
900	240.7	95.14	190.3	1.22	124 9	2 75	281.0	4.88	490.6	7.68	780.5
1000	253 8	105.6	211 2	1.29	146.2	2.89	329.0	5.16	584.8	8.04	914.0

TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head. Feet.	Velocity pr sec. Feet.	150 M inch. 3 cu ft H. P.	200 M inch. 4 cu ft H. P.	Diameters of Nozzles. 3 inches.		3 5 inches.		4 inches.		4.5 inches.	
				cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
1	8.025	.308	.424	.372	.040	.50	.066	.656	.072	.81	.090
1.5	9.83	.474	.632	.444	076	.61	105	.800	.136	1.00	.171
2	11.35	.633	.844	.520	.116	.70	.160	.928	.208	1.17	.260
2.5	12.68	.792	1.06	.58	.164	.79	.224	1.02	.288	1.30	.370
3	13.90	.951	1.27	.636	.216	.86	.295	1.14	.384	1.43	.485
3.5	15.01	1.110	1.48	.684	.272	.94	370	1.22	.480	1.54	.612
4	16.05	1.26	1.68	.742	.332	1.02	.452	1.30	.592	1.64	.742
4.5	17.02	1.42	1.90	.776	.396	1.06	.540	1.38	.704	1.74	.815
5	17.95	1.58	2 12	.820	.452	1.11	.600	1.46	.816	1.84	1.02
6	19.66	1.90	2.54	.896	.612	1.22	.833	1.60	1.09	2.01	1.38
7	21.23	2.22	2.96	.968	.772	1.32	1.05	1.73	1.38	2.18	1.74
7.5	21.98	2.38	3.16	1.00	.856	1 36	1.16	1.78	1.52	2.25	1.92
10	25.38	3.18	4.24	1.16	1.32	1.57	1.79	2 16	2.34	2.61	2.97
12.5	28.37	3.96	5.28	1.30	1.84	1.76	2.50	2.30	3.46	2.92	4.14
15	31.08	4.77	6.36	1.42	2.42	1.93	3.29	2.53	4.32	3.19	5.44
17.5	33.57	5.55	7 40	1.53	3.13	2.08	4.20	2.72	5.44	3.44	7.04
20	35.89	6.33	8.44	1.64	3.72	2.23	5.07	2.91	6.64	3.69	8.37
22.5	38.07	7.14	9.52	1.74	4.44	2.36	6.65	3.09	7.92	3.91	9.99
25	40.13	7.92	10.56	1.83	5.20	2.54	7.08	3.26	9.24	4.12	11.70
27.5	42.08	8.70	11.60	1.92	6.00	2 61	8.17	3.41	10.68	4.32	13.50
30	43.95	9.06	12.08	2.05	6 84	2.79	9.31	3.65	12.16	4.61	15.39
32.5	45.75	10.02	13.36	2.09	7.72	2.84	10.50	3.71	13.72	4.70	17.37
35	47.47	11.07	14.76	2.17	8.60	2.95	11.71	3.86	15.32	4.88	19.35
40	50.75	12.66	16.88	2.22	10.52	3.15	14.83	4.12	18.72	5.22	23.67
45	53.83	14.25	19.00	2.46	12.56	3.34	17.10	4.36	22.40	5.54	28.25
50	56.75	15.84	21.12	2.53	14.72	3.52	20.03	4.60	26.24	5.83	32.12
60	62.10	19.02	25.36	2.84	19.36	3.86	26.32	5.04	34.40	6.39	43.55
70	67.14	22.17	29.56	3.06	24.40	4.17	33.17	5.42	43.36	6.84	54.90
80	71.78	25.33	33.86	3.28	20.80	4.40	40.55	5.81	52.96	7.38	67.06
90	76.13	28.59	38.12	3.46	35.52	4.73	48.37	6.16	63.20	7.78	79.92
100	80.25	31.68	42.24	3.66	41.64	4.98	56.67	6.52	74.08	8.23	93.70
125	89.72	39.63	52.84	4.08	58.20	5.57	79.20	7.28	103.5	9.18	130.9
150	98.28	47.55	63.40	4.48	76.48	6.10	104.10	8.00	136 0	10.08	172.1
175	106.1	55.50	74.00	4.84	96.28	6.60	131.07	8.04	171.2	10.89	216.6
200	113.5	63.42	84.56	5.10	117.7	7.05	160.22	9.20	219.6	11.61	261.7
250	127.1	79.26	105.7	5 80	164.5	7.88	223.92	10.32	292.8	13.05	370.2
300	139.0	95.10	126.8	6.36	216.3	8.63	294.3	11.28	384.0	14.31	486 9
350	150.1	111.2	148.3	6.84	272.6	9.33	371.2	12.20	484.8	15.39	613.2
400	160.5	126.8	169.1	7.32	323.0	9.97	453.2	13.04	592.0	16.47	749.2
450	170.2	142.9	190.6	7.76	397.4	10.58	541.0	13.84	707.2	17.46	894.2
500	179.4	158.5	211.4	8.20	466.0	11.15	627.0	14.56	827.2	18.45	1043.
550	188.2	174.7	232.8	8.40	536.8	11.69	731.0	15.23	955.2	18.90	1208.
600	196.6	190.2	253.6	8.92	611.0	12.21	832.7	15.96	1080.0	20.07	1376.
700	212.3	221.9	296.0	9.84	771.2	13.31	1051.	17.44	1371.2	22.14	1735.
800	226.9	253.6	338.2	10 32	942.0	14.10	1282.	18.40	1675.2	23.22	2119.
900	240.7	285.4	380.6	11.00	1124.	14.9	1530.	19.52	1998.4	24.75	2529.
1000	253 8	316.8	422.4	11.56	1316.	15.76	1791.	20.64	2280.2	26.00	2961.

TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head. Feet.	Velocity pr sec Feet.	300 M inch. 6 cu ft. H. P.	400 M inch. 8 cu ft H. P	Diameters of Nozzles. 5 inches.		5.5 inches.		6 inches.		7 inches.	
				cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
1	8.025	.616	8.8	1.02	116	1 23	140	1 49	100	1 99	.226
1.5	9.83	.948	1.26	1.25	.212	1.51	.257	1.78	.304	2.44	.420
2	11.35	1.27	1.69	1.44	.327	1.74	.395	2 08	464	2 82	641
2.5	12.68	1.58	2.11	1.61	.457	1.95	.553	2.32	656	3 15	.896
3	13.90	1.90	2.54	1.76	.601	2.13	.727	2.54	.864	3 45	1.18
3.5	15.01	2.22	2.96	1.90	.757	2.31	.916	2.74	1.09	3.78	1.48
4	16.05	2.53	3.37	2 03	.925	2 46	1 12	2.97	1.33	4.09	1.81
4.5	17.02	2.84	3.79	2.16	1.10	2.51	1.33	3.10	1.58	4.23	2.16
5	17 95	3.18	4.24	2 27	1.26	2 75	1.53	3 28	1.81	4.40	2.48
6	19.66	3.81	5.08	2.49	1.70	3.02	2.05	3.58	2.45	4.88	3.33
7	21.23	4.44	5.92	2.69	2 14	3.26	2.59	3.87	3.09	5.28	4.20
7 5	21.98	4.74	6.32	2.79	2.38	3.42	2.87	4.00	3.42	5.40	4.66
10	25.38	6.36	8.48	3.22	3.66	3.89	4.42	4.64	5.28	6.30	7.16
12.5	28.37	7.92	10.56	3.59	5.11	4.3	6.18	5.20	7.36	7.05	10.02
15	31 08	9.54	12.72	3.94	6.72	4.76	8.13	5.68	8.08	7.72	13.17
17.5	33.57	11.10	14.80	4.26	8.46	5.15	10.24	6.12	12.52	8.34	16.80
20	35.80	12.66	16.88	4.55	10.34	5.50	12.51	6 56	14.88	8.92	20.28
22.5	38.07	14.28	19.04	4.83	12.34	5.84	14.93	6.96	17.76	9 46	24.20
25	40.13	15.84	21.12	5.09	14.45	6.16	17.49	7.32	20.80	10.15	28.33
27.5	42.08	17.40	23.20	5.34	16.67	6.46	20.18	7.68	24.00	10.40	32.08
30	43.95	18.12	24.16	5.70	19.00	6.90	22.99	8.20	27.36	11.18	87.25
32.5	45.75	20.04	26.72	5.80	21.42	7.02	25.92	8.36	30.88	11.37	41.99
35	47.47	22.14	29.52	6.02	23.94	7.28	28.97	8.68	33.40	11.80	46.84
40	50.75	25 32	33.76	6.44	29.25	7.78	83.39	9.28	42.08	12.61	57.33
45	53.83	29.50	38.00	6.82	34.90	8 26	42.23	9.84	50.24	13.38	68.40
50	56.75	31.68	42.24	7.19	40.87	8.70	49.46	10.36	58.88	14.10	80.11
60	62.16	38.04	50.72	7.88	53.72	9.54	65.01	11.36	77.44	15.44	105.3
70	67.14	44.34	59.12	8.51	67.72	10.30	81.95	12.24	97.60	16.69	132.7
80	71.78	50.74	67.64	9.10	82.76	11.01	100.1	13.12	119.2	17 84	162.2
90	76.13	57.18	76.24	9.65	98.72	11.58	119.5	13.84	142.1	18.92	193.5
100	80.25	63.36	84.48	10.17	115.6	12.31	139.9	14.64	166.6	19.94	226.7
125	89.72	79.26	95.68	11.38	161.6	13.76	195.0	16.32	232 8	22.30	316.8
150	98.28	95.10	126.8	12.46	212.5	15.08	257.0	17.92	305.9	24.42	416.4
175	106.1	111.0	148.0	13.46	267.5	15.29	313.7	19.36	385.1	26.39	524.3
200	113.5	126.8	169.1	14.34	327.0	17.51	395.7	20.64	470.8	28.20	640.9
250	127 1	158.5	211.4	16.09	457.0	19.47	553.0	3.20	658.0	31.54	895.7
300	139.0	190.2	253.6	17.62	601.0	21.33	726.9	25.24	865.2	34.54	1177.
350	150.1	222.5	296.6	19.04	757.2	22.04	916.3	27.36	1090.4	37.32	1485.
400	160.5	253.6	338.2	20.35	925.0	24.62	1179.	29.28	1332.	29.80	1813.
450	170.2	285.8	381.1	21.59	1104.	26.12	1335	31.04	1590.	42.31	2164.
500	179.4	317.1	422.8	22.75	1293.	27.54	1565.	32.80	1864.	44.00	2508.
550	188.2	349.2	465.6	23.86	1491.	28.88	1805	33 60	2147	46.78	2923.
600	196.0	380.4	507.2	24.93	1699.	30.16	2056.	35.08	2446.	48.86	3331.
700	212.3	444.0	592.0	27.18	2142.	32.88	2591.	39.36	3085.	53.26	4203.
800	226.9	507.3	6 6.4	28.77	2616.	34.92	3166.	41.28	3768.	56.40	5129.
900	240.7	570.9	761.2	30.52	3122.	36.94	3778	44.00	4496.	59.83	6120.
1000	253 8	633.6	844.8	32.17	3656.	38.93	4424.	46.24	5264.	63.06	7166.

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TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head.	Velocity pr sec	500 Min. inch. 10 c ft	1000 Min. inch. 20 c ft	Diameters of Nozzles.							
				8 inches.		9 inches.		10 inches.		12 inches.	
Feet.	Feet.	H. P.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
1	8.025	1.06	2.12	2.62	.288	3.35	.360	4.07	.46	5.96	.904
1.5	9.83	1.58	3.16	3.20	.544	3.99	.684	4.99	.85	7.12	1.68
2	11.35	2.11	4.22	3.71	.832	4.68	1.04	5.76	1.3	8.32	2.56
2.5	12.68	2.64	5.28	4.08	1.15	5.22	1.48	6.44	1.83	9.28	8.58
3	13.90	3.17	6.34	4.56	1.54	5.72	1.94	7.05	2.40	10.16	4.72
3.5	15.01	3.70	7.40	4.88	1.92	6.16	2.45	7.62	3.03	10.96	5.92
4	16.05	4.21	8.42	5.20	2.37	6.58	2.99	8.14	3.70	11.88	7.24
4.5	17.02	4.74	9.48	5.52	2.81	6.98	3.26	8.64	4.42	12.40	8.64
5	17.95	5.28	10.6	5.84	3.26	7.38	4.07	9.10	5.05	13.12	9.92
6	19.66	6.34	12.7	6.40	4.36	8.06	5.51	9.97	6.80	14.32	13.32
7	21.23	7.39	14.8	6.92	5.52	8.71	6.95	10.77	8.57	15.48	16.80
7.5	21.98	7.92	15.8	7.12	6.08	9.00	7.70	11.14	9.50	16.00	18.64
10	25.38	10.6	21.2	8.64	9.36	10.41	11.88	12.87	14.63	18.56	28.64
12.5	28.37	13.2	26.4	9.20	13.84	11.70	16.56	14.39	20.44	20.80	40.08
15	31 08	15.9	31.8	10.12	17.28	12.78	21.78	15.76	26.87	22.72	52.68
17.5	33.57	18.5	37.0	10.88	21.76	13.77	28.17	17.03	33.86	24.48	67.20
20	35.89	21.1	42.2	11.64	26.56	14.76	33.48	18.20	41.37	26.24	81.12
22.5	38.07	23.8	47.6	12.36	31.68	15.66	39.96	19.31	49.37	27.84	96.80
25	40.13	26.4	52.8	13.04	36.96	16.47	46.80	20.35	57.82	29.28	113.3
27.5	42.08	29.0	58.0	13.64	42.72	17.28	54.00	21.34	66.70	30.72	130.7
30	43.95	30.2	60.4	14.60	48.64	18.45	61.56	22.81	76.01	32.80	149.0
32.5	45.75	33.4	66.8	14.84	54.88	18.81	69.48	23.20	85.70	33.44	168.9
35	47.47	36.9	73.8	15.44	61.28	19.53	77.40	24.08	95.78	34.72	187.4
40	50.75	42.2	84.4	16.48	74.88	20.88	94.68	25.74	117.0	37.12	229.3
45	53.83	47.5	95.0	17.44	89.60	22.14	113.0	27.30	139 6	39.36	273.6
50	56.75	52.8	105.6	18.40	105.0	23.31	128.5	28.78	163.5	41.44	320.4
60	62.16	63.4	126.8	20.16	137.6	25.56	174.2	31.53	214.9	45.44	421.2
70	67.14	73.9	147.8	21.68	173.4	27.54	219.6	34.06	270.9	48.96	530.8
80	71.78	84.6	169.0	23.36	211.8	29.52	268.2	36.41	331.0	52.48	648.8
90	76.13	95.3	190.6	24.64	252.8	31.14	319.7	38.61	394 9	55.36	774.0
100	80.25	105.6	211.2	26.08	296.3	32.94	374.8	40.70	462.5	58.56	906.8
125	89.72	182.1	264.2	29.12	414.0	36.72	523.8	45.51	646.5	65.28	1267.
150	98.28	158.5	317.0	32.00	554.0	40.32	688.3	49.85	849.8	71.68	1666.
175	106.1	185.0	370.0	34.56	684.8	43.56	866.5	53.85	1070.	77.44	2097.
200	113.5	211.4	422.8	36.80	878.4	46.44	1059.	57.56	1308.	82.56	2564.
250	127.1	264.2	528.4	41.28	1171.	52.20	1481.	64.36	1828.	92.80	3583.
300	139.0	317.0	634.0	45.12	1536.	57.24	1947.	70.50	2403.	101.76	4708.
350	150.1	370.8	741.6	48.80	1949.	61.56	2453.	76.15	3029.	109.4	5940.
400	160.5	422.7	845.4	52.16	2368.	65.88	2997.	81.41	3700.	117.1	7252.
450	170.2	476.4	952.8	55.36	2829.	69.84	3577.	86.35	4415.	124.2	8656
500	179.4	528.4	1057.	58.24	3409.	73.80	4194.	91.02	5172.	131.2	10032
550	188.2	582.2	1164.	61.12	3821.	75.60	4831.	95.46	5966.	134.4	11692.
600	196.6	634.1	1268.	63.84	4352.	80.28	5504.	99.71	6798.	142.7	13324.
700	212.3	739.8	1480.	69.76	5485.	88.56	6191.	108.7	8567.	157.4	16812.
800	226.9	845.5	1691.	73.60	6701.	92.88	8478	115.1	10468.	165.1	20516
900	240.7	951.4	1903.	78.08	7994.	99.00	10116.	122.5	12489.	176.0	24480
1000	253.8	1056.	2112.	82.56	9357.	104.0	11844.	128.7	14624.	185.0	28664

RISDON IRON WORKS CO.

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TABLES

—FOR—

Calculating the Horse-Power of Water.

MINERS' INCH TABLE

The following table gives the Horse-Power of one miner's inch of water under heads from one up to eleven hundred feet. This inch equals 1½ cubic feet per minute.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0024147	320	.772704
20	.0482294	330	.796851
30	.072441	340	.820998
40	.096588	350	.845145
50	.120735	360	.869292
60	.144882	370	.893439
70	.169029	380	.917586
80	.193176	390	.941733
90	.217323	400	.965880
100	.241470	410	.990027
110	.265617	420	1.014174
120	.289764	430	1.038321
130	.313911	440	1.062468
140	.338058	450	1.086615
150	.362205	460	1.110762
160	.386352	470	1.134909
170	.410499	480	1.159056
180	.434646	490	1.183206
190	.458793	500	1.207350
200	.482940	520	1.255644
210	.507087	540	1.303938
220	.531234	560	1.352232
230	.555381	580	1.400526
240	.579528	600	1.448820
250	.603675	650	1.569555
260	.627822	700	1.690290
270	.651969	750	1.811025
280	.676116	800	1.931760
290	.700263	900	2.173230
300	.724410	1000	2.414700
310	.748557	1100	2.656170

CUBIC FEET TABLE

The following table gives the Horse-Power of one cubic foot of water per minute under heads from one up to eleven hundred feet.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0016098	320	.515136
20	.032196	330	.531234
30	.048294	340	.547332
40	.064392	350	.563430
50	.080490	360	.579528
60	.096588	370	.595626
70	.112686	380	.611724
80	.128784	390	.627822
90	.144892	400	.643920
100	.160980	410	.660018
110	.177078	420	.676116
120	.193176	430	.692214
130	.209274	440	.708312
140	.225372	450	.724410
150	.241470	460	.740508
160	.257568	470	.756606
170	.273666	480	.772704
180	.289764	490	.788802
190	.305862	500	.804900
200	.321960	520	.837096
210	.338058	540	.869292
220	.354156	560	.901488
230	.370254	580	.933684
240	.386352	600	.965880
250	.402450	650	1.046370
260	.418548	700	1.126860
270	.434646	750	1.207350
280	.450744	800	1.287840
290	.466842	900	1.448820
300	.482940	1000	1.609800
310	.499038	1100	1.770780

When the Exact Head is Found in Above Table

EXAMPLE.—Have 100 foot head and 50 inches of water. How many Horse-Power?

By reference to above table the Horse-Power of 1 inch under 100 feet head is .241470. This amount multiplied by the number of inches, 50, will give 12.07 Horse-Power.

When Exact Head is Not Found in Table

Take the Horse-Power of 1 inch under 1 foot head and multiply by the number of inches, and then by number of feet head. The product will be the required Horse-Power.

NOTE.—The above formula will answer for the cubic feet table, by substituting the equivalents therein for those of miner's inches.

Horse-Power given in above Table=85 per cent of Theoretical Power.

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Diameters, Circumferences and Areas of Circles,

IN FEET,

And Contents in Gallons at One Foot in Depth.

Diam-eter.		Circum.		Area, in feet.	Gallons, 1 foot in depth.	Diam-eter.		Circum.		Area, in feet.	Gallons, 1 foot in depth.	Diam-eter.		Circum.		Area, in feet.	Gallons, 1 foot in depth.
Feet.	Inches.	Feet.	Inches.			Feet.	Inches.	Feet.	Inches.			Feet.	Inches.	Feet.	Inches.		
1		3	1⅝	.78	5 87	6		18	10⅛	28.27	211.44	19		59	8¼	283.52	2120.34
1	1	3	4⅝	.92	6.89	6	3	19	7½	30.67	229.43	19	3	60	5⅝	291.03	2176.51
1	2	3	8	1.06	7.99	6	6	20	4⅞	33.18	248.15	19	6	61	3⅛	298.64	2233.29
1	3	3	11	1.22	9.17	6	9	21	2⅜	35.78	267.61	19	9	62	½	306.35	2291.04
1	4	4	2⅛	1.39	10.44												
1	5	4	5⅜	1.57	11 78	7		21	11⅞	38.48	287.80	20		62	9⅞	314.16	2349.41
1	6	4	8½	1.76	13.21	7	3	22	9¼	41.28	308.72	20	3	63	7⅜	322.06	2408.51
1	7	4	11⅝	1.96	14.72	7	6	23	6¾	44.17	330.38	20	6	64	4¾	330.06	2468.35
1	8	5	2¾	2.18	16 31	7	9	24	4⅛	47.17	352.76	20	9	65	2¼	338.16	2528.92
1	9	5	5⅞	2.40	17 98												
1	10	5	9	2.63	19.74	8		25	1½	50.26	375 90	21		65	11⅜	346.36	2590.22
1	11	6		2.88	21.48	8	3	25	11	53.45	399.76	21	3	66	9	354.65	2652 25
						8	6	26	8⅜	56.74	424.36	21	6	67	6½	363.05	2715.04
2		6	3⅜	3.14	23.49	8	9	27	5¾	60.13	449.21	21	9	68	3⅞	371.54	2778.54
2	1	6	6½	3.40	25 49												
2	2	6	9⅝	3.68	27.57	9		28	3¼	63.61	475.75	22		69	1⅜	380.13	2842 79
2	3	7	¾	3.97	29.73	9	3	29	⅝	67.20	502 55	22	3	69	10¾	388.82	2907.76
2	4	7	3⅞	4.27	32.69	9	6	29	10⅛	70.88	530.08	22	6	70	8¼	397.60	2973 48
2	5	7	7	4 58	34.30	9	9	30	7½	74.66	558.35	22	9	71	5⅝	406.49	3039.92
2	6	7	10¼	4.90	36.70												
2	7	8	1⅜	5.24	39.19	10		31	5	78.54	587.35	23		72	3	415.47	3107.10
2	8	8	4½	5.58	41 76	10	3	32	2⅜	82.51	617.08	23	3	73	½	424.55	3175 01
2	9	8	7⅝	5 93	44.41	10	6	32	11¾	86.59	647.55	23	6	73	9⅞	433.73	3243.65
2	10	8	10¾	6.30	47.15	10	9	33	9¼	90.76	678.27	23	9	74	7¼	443.01	3313.04
2	11	9	1⅞	6.68	49.96												
						11		34	6⅝	95.03	710.69	24		75	4¾	452 39	3383.15
3		9	5	7.06	52.86	11	3	35	4⅛	99 40	743.36	24	3	76	2⅛	461.86	3454.00
3	1	9	8¼	7.46	55.83	11	6	36	1½	103.86	776.77	24	6	76	11⅝	471.43	3525.59
3	2	9	11⅜	7.87	58.89	11	9	36	10⅞	108.43	810.91	24	9	77	9	481.10	3597.90
3	3	10	2½	8.29	62.03												
3	4	10	5⅝	8.72	65.26	12		37	8⅜	113.09	848.18	25		78	6⅜	490.87	3670.95
3	5	10	8¾	9.16	68 51	12	3	38	5¾	117.85	881.39	25	3	79	3⅞	500.74	3744 74
3	6	10	11⅞	9.62	73.15	12	6	39	3¼	122.71	917 73	25	6	80	10¼	510.70	3819.26
3	7	11	3	10.08	75 41	12	9	40	⅝	127.67	954.81	25	9	80	10¾	520.76	3894.52
3	8	11	6⅛	10.55	78.96												
3	9	11	9⅜	11.04	82.59	13		40	10	132.73	992.62	26		81	8⅛	530.93	3970.50
3	10	12	½	11.54	86.30	13	3	41	7½	137 88	1031.17	26	3	82	5¼	541 18	4047.23
3	11	12	3⅝	12.04	90.10	13	6	42	4⅞	143.13	1070 45	26	6	83	3	551.54	4124 68
						13	9	43	2¼	148 48	1108.06	26	9	84	⅜	562.00	4202.96
4		12	6¾	12.56	93 97												
4	1	12	9⅞	13 09	97 93	14		43	11¾	153 93	1151.21	27		84	9⅞	572.55	4281.80
4	2	13	1	13 63	101.97	14	3	44	9⅛	159 48	1192.69	27	3	85	7⅛	583.20	4361.46
4	3	13	4⅛	14.18	103.03	14	6	45	6⅝	165 13	1234 91	27	6	86	4⅝	593.95	4441.86
4	4	13	7¼	14.74	110 29	14	9	46	4	170 87	1277.86	27	9	87	2⅛	604.80	4522.98
4	5	13	10½	15.32	114.57												
4	6	14	1⅝	15.90	118.93	15		47	1½	176.71	1321.54	28		87	11½	615.75	4604 85
4	7	14	4⅝	16.49	123.38	15	3	47	10⅞	182.65	1365 96	28	3	88	9	626.79	4686.48
4	8	14	7⅞	17.10	127.91	15	6	48	8¼	188.69	1407.51	28	6	89	6⅜	637.94	4770.77
4	9	14	11	17.72	132 52	15	9	49	5¾	194.82	1457.00	28	9	90	3¾	649 18	4854.84
4	10	15	2⅛	18.34	137.21												
4	11	15	5¼	18.98	142.05	16		50	3⅛	201.06	1503 62	29		91	1¼	660.52	4939.64
						16	3	51	½	207.39	1550.97	29	3	91	10⅝	671.95	5025.17
5		15	8½	19.63	146.83	16	6	51	10	213.82	1599.06	29	6	92	8⅛	683.49	5111.44
5	1	15	11⅝	20.29	151.77	16	9	52	7⅜	220 35	1647.89	29	9	93	5½	695.12	5198.44
5	2	16	2¾	20.96	156.78												
5	3	16	5¾	21.64	161.88	17		53	4⅞	226.98	1697.45	30		94	2⅞	706.86	5286.18
5	4	16	9	22.34	167.06	17	3	54	2⅛	233.70	1747.74	30	3	95	⅜	718.69	5374.65
5	5	17	⅛	23.04	172.33	17	6	54	11⅝	240.52	1798 76	30	6	95	9¾	730.61	5463.85
5	6	17	3¼	23.75	177 67	17	9	55	9⅛	247.45	1850.53	30	9	96	7¼	742.64	5553.79
5	7	17	6⅜	24.48	183 09												
5	8	17	9⅝	25.21	188.60	18		56	6½	254.46	1903.02						
5	9	18	⅜	25.96	194.19	18	3	57	4	261.58	1956.25						
5	10	18	3⅞	26 72	199.86	18	6	58	1⅜	268.80	2010.21						
5	11	18	7⅛	27 49	205.61	18	9	58	10¾	276.11	2064.91						

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GOLD TABLE

FOR DETERMINING THE

Value of Free Gold per Ton (2,000 lbs.) of Quartz or Cubic Yard of Gravel,

PREPARED BY

MELVILLE ATWOOD, F. G. S., Consulting Mining Engineer.

Weight, Washed Gold. 4-lb. Sample. Grains.	Fineness, 780 Value per Oz., $16 12	Fineness, 830. Value per Oz., $17.15	Fineness, 875. Value per Oz., $18.08	Fineness, 920. Value per Oz., $19.01
5 grains.	$83.97	$89.36	$94.20	$99.05
4 "	67.18	71.49	75.36	79.24
3 "	50.38	53.61	56.52	59.43
2 "	33.59	35.74	37.68	39.62
1 "	16.79	17.87	18.84	19.81
.9 "	15.11	16.08	16.95	17.82
.8 "	13.43	14.29	15.07	15.84
.7 "	11.75	12.51	13.19	13.86
.6 "	10.07	10.73	11.30	11.88
.5 "	8.40	8.93	9.42	9.90
.4 "	6.71	7.14	7.53	7.92
.3 "	5.03	5.36	5.65	5.94
.2 "	3.36	3.57	3.76	3.96
.1 "	1.68	1.78	1.88	1.98

Explanation of Table.

The foregoing table furnishes an exceedingly simple method of determining the value of *free gold* in a ton of gold-bearing quartz, or a cubic yard of auriferous gravel.

Take a sample of four pounds of quartz; pulverize it to the usual fineness for horning; wash it carefully by batea or other means; amalgamate the gold by the application of quicksilver; volatalize the quicksilver by blow-pipe or otherwise; weigh the resulting button, and the value given in the table opposite such weight will be the value in free gold per ton of 2,000 pounds of quartz.

EXAMPLE.

Sample of four pounds produces button weighing one grain, the finest of the gold being 830; then the value of one ton of such quartz will be $17.87.

If the sample of four pounds should produce a button weighing say two and four-tenths grains, then the value of such quartz would be (875 fine) as follows, viz:

Opposite 2 grains .....875 fine.....value $37.68
" 4-10 grain .....875 " ..... " 7.53

Total value per ton (2,000 lbs.) $45.21

Gold Value of a Cubic Yard of Gravel.

To determine the gold value of a cubic yard of auriferous gravel, the foregoing table can be used.

Take a sample of sixty pounds of gravel; pulverize it, and carefully wash it by batea, pan or otherwise; amalgamate the gold; volatalize the quicksilver; weigh the button, and in column in foregoing table, opposite the weight, will be found the gold value of a cubic yard of the gravel.

EXAMPLE.

Sample of sixty pounds produces button weighing one grain, the fineness of the gold being 780; then the value of one cubic yard of such gravel would be $1.67. This is arrived at by pointing off one point, or dividing the value given in table by 10.

If the sample of sixty pounds yields a button weighing one and two-tenths grains, then the value of the gravel per cubic yard would be—gold being 920 fine—as follows:

Opposite 1 grain.....920 fine.....value $1.98
" 2-10 grain.....920 " ..... " .03+

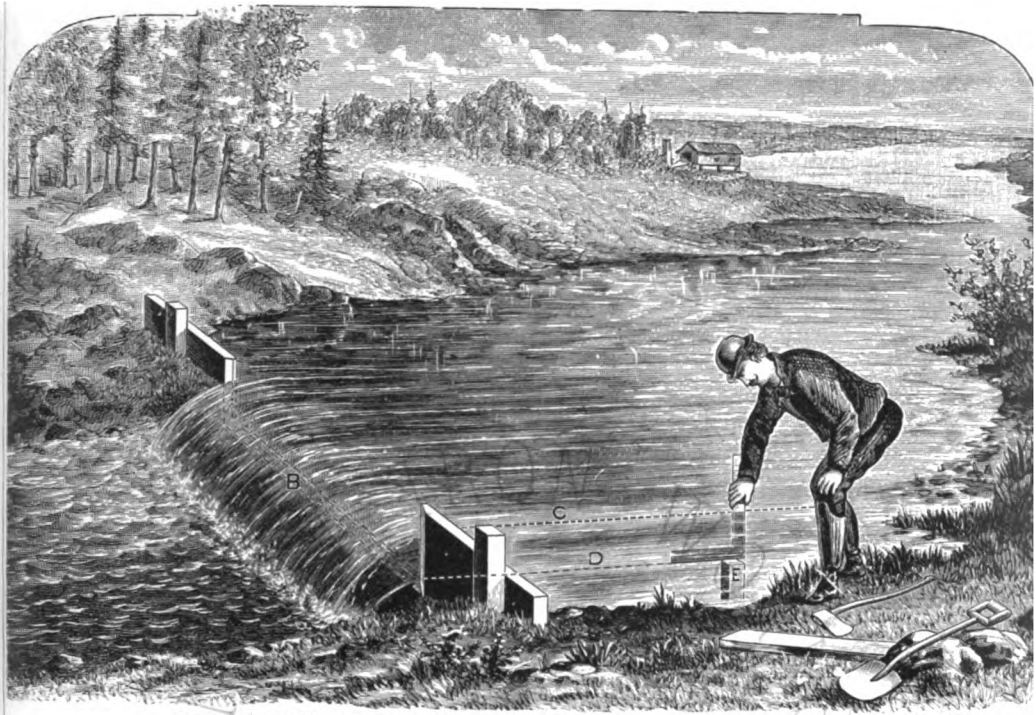
Total value cubic yard..... $2.01+

This table is prepared upon the following basis of weights, viz: A sample of four pounds of quartz is the five-hundredths part in weight of a ton of 2,000 pounds, and the gold values given are reduced to this proportion.

Eighteen cubic feet of gravel in bank will weigh one ton, or 2,000 pounds, and a cubic yard, or twenty-seven cubic feet, will weigh 3,000 pounds, or 1½ tons; and sixty pounds being the fiftieth part of the weight of a cubic yard, then the relative proportion of the weight of quartz to gravel is as 50 to 500, or 1 to 10.

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MEASUREMENT OF WATER.



WEIR DAM FOR MEASUREMENT OF WATER

WEIR TABLE FROM ONE-SIXTEENTH INCH DEPTH TO TWENTY-FIVE INCHES DEPTH.

Inches		1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16		Inches
		.006	.01	.03	.05	.07	.09	.11	.14	.17	.20	.23	.26	.30	.33	.36		
1	.40	.43	.47	.51	.55	.60	.65	.70	.74	.78	.83	.87	.93	.98	1.03	1.08	.40	1
2	1.14	1.19	1.24	1.30	1.36	1.41	1.47	1.52	1.59	1.65	1.71	1.77	1.83	1.89	1.96	2.02	1.14	2
3	2.09	2.16	2.23	2.29	2.36	2.43	2.50	2.57	2.63	2.71	2.78	2.85	2.92	2.99	3.07	3.14	2.09	3
4	3.22	3.29	3.37	3.44	3.52	3.60	3 68	3.75	3.83	3.91	3.99	4.07	4.16	4 24	4.32	4.41	3.22	4
5	4.50	4.58	4.67	4.75	4.84	4.92	5.01	5.10	5.18	5.27	5.36	5.45	5.54	5.63	5.72	5 81	4.50	5
6	5.90	6.00	6.09	6.18	6.28	6.37	6.47	6.56	6 65	6.75	6.85	6.95	7.05	7.15	7.25	7.35	5.90	6
7	7.44	7.54	7.64	7.74	7.84	7.94	8.05	8.15	8.25	8.35	8.45	8.55	8.66	8.76	8.86	8.97	7 44	7
8	9.10	9.20	9.31	9.42	9.52	9.63	9.74	9.85	9.96	10.07	10.18	10.29	10.40	10.51	10.62	10.73	9 10	8
9	10.86	10.97	11.08	11.19	11.31	11.42	11.54	11.65	11.77	11.88	12.00	12.12	12.23	12.35	12.47	12.59	10.86	9
10	12.71	12.83	13.95	13.07	13.19	13.31	13.43	13.55	13.67	13.80	13.93	14.04	14.16	14.30	14.42	14.55	12.71	10
11	14.67	14.79	14.92	15.05	15.18	15 30	15.43	15.56	15.67	15.81	15.96	16.08	16.20	16.34	16.46	16.59	14.67	11
12	16.73	16.86	16.99	17.12	17.26	17.39	17.52	17.65	17.78	17.91	18.05	18.18	18.32	18.45	18.58	18.72	16 73	12
13	18.87	19.01	19.14	19.28	19.42	19.55	19.69	19.83	19.97	20.10	20.24	20.38	20.52	20.60	20.80	20.94	18 8	13
14	21.09	21.23	21 37	21.48	21.65	21.79	21.94	22.08	22.22	22.35	22.51	22.65	22.79	22.94	23.08	23.23	21.09	14
15	23.38	23.53	23.67	23.82	23.97	24.11	24.26	24.41	24.56	24.71	24.86	25.01	25.16	25.31	25.46	25.61	23.38	15
16	25.76	25.91	26.06	26.21	26.36	26.51	26.66	26.81	26.97	27.12	27.27	27.43	27.58	27.73	27.89	28.04	25.76	16
17	28.20	28.35	28.51	28.66	28 82	28.98	29.14	29.29	29.45	29.60	29.76	29.92	30.08	30.23	30.39	30.55	28.20	17
18	30.70	30.86	31.02	31.18	31.34	31.50	31.66	31.81	31.98	32.15	32.31	32.47	32.63	32.80	32.96	33.12	30.70	18
19	33.29	33.45	33.61	33.78	33.94	34.11	34.27	34.44	34.60	34.77	34.94	35.10	35.27	35.44	35.6	35.77	33.29	19
20	35.94	36.10	36.27	34.46	36.60	37.87	36.94	37.11	37.28	37.45	37.62	37.79	37.96	38.14	38 31	38 48	35.94	20
21	38.65	38.82	39.00	39.17	39.34	39.52	39.69	39.86	40 04	40.21	40.30	40.56	40.73	40.91	41.09	41.26	38 65	21
22	41.43	41.60	41.78	41.96	42 13	42.31	42.49	42.67	42.84	43 02	43.20	43.38	43.56	43.74	43.92	44.10	41.43	22
23	44.28	44.46	44.64	44.82	45.00	45.18	45 38	45.53	45.71	45 90	46.08	46.26	46 43	46.63	46 81	47.00	44.28	23
24	47.18	47.36	47.55	47.72	47.91	48.09	48.28	48 46	48.65	48.83	49.02	49 20	49.39	49·58	49.76	49.93	47.18	24

Table gives cubic feet per minute for every inch in breadth of weir.

MEASUREMENT OF WATER AND DESCRIPTION OF WEIR DAM.

When a man has concluded to improve a water power, the first thing he should ascertain is the amount of head and fall he can secure. The next and most important step is to determine accurately the quantity of water that flows in the stream (provided there is a limited supply), as upon this will depend the amount of power, and consequently the amount of work, the stream is capable of performing. And, as the improvement of water power is necessarily attended with expense, it is therefore important, to one who contemplates building a mill or factory, that he should know exactly what amount of work he can depend upon the stream doing; as, for the want of an accurate knowledge, or from an erroneous supposition of the quantity of water in the stream, parties frequently construct mills and factories of a magnitude which, upon trial, is found to be entirely out of proportion to the power of the stream, and it fails to drive their machinery. Such being often the case, it is important, when practicable, to get some one well versed in hydraulics to measure the capacity of the stream. As this cannot always be done, we give herewith a few plain suggestions and illustrations, by the aid of which any one can determine approximately the quantity of water in a stream.

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The plate represents a weir dam across a small stream. Where it is convenient to use a single board, as shown in the cut, select one that is long enough to reach across the stream, resting in the bank at each end. Cut a notch in the board sufficient in depth to pass all the water to be measured, and not more than two-thirds of the width of the stream in length. The bottom of notch B in the board A should be beveled on the down-stream side; the ends of the notch should also be beveled on the same side, and within one-eighth of an inch of the upper side of the board, leaving the edge almost sharp. E is a stake driven in the bottom of stream several feet above the board or dam, and should be driven down to the level of notch B, this level being easily found as the water is beginning to spill over the board. After the water has come to a stand, and reached its greatest depth, a careful measurement can be made of the depth of water over the top of stake E, as illustrated in the cut by the man with square and measure in hand. Such measurement gives the true depth of water passing over the notch, since, if measured directly on the notch or the board, the curvature of the water in passing would reduce the depth, giving the improper measure. Although, where accuracy is not required, such a method will give a fair estimate of the quantity of water; in all cases it is best to make the measurement over the stake. The line D is a level from the bottom of notch B to the top of stake E; while the dotted line C represents the top of the water, and the distance between the *lines* or from the top of stake gives the *true depth* or spill over the weir. The lines have, in the cut, the appearance of running over the top of the board; but this is owing to the fact that they pass behind it, and, for the purpose of illustration, the reader is supposed to look through the board and the post. The surface of the water below the board should not be nearer the notch B than ten inches, that the flow of water over the notch may not be impeded. Neither should the nature of the channel above the board be such as to force or hurry the water to the board, but it should be of ample width and depth to allow the water to approach the notch and board steadily and quietly. If the water passes the channel rapidly it will be forced over the notch, and a larger quantity will pass than if allowed to spill from a large body moving slowly.

When the depth of water over the stake E is known, the quantity of water passing can be easily calculated by reference to the Weir Table on opposite page. This table gives the number of cubic feet of water passing per minute over a weir for each inch in breadth, from one-sixteenth of an inch in depth to twenty-five inches depth. The figures, 1, 2, 3, etc., in the first and last perpendicular columns, are the inches depth of water over weir, while the first or top horizontal column represents fractional parts of an inch, from one-sixteenth to sixteen-sixteenths. The body of the table shows the cubic feet and decimal parts of a cubic foot that will pass each minute for each depth of weir, from one-sixteenth to twenty-five inches, as before stated. But each result is for but one inch in width; so, for any particular number of inches breadth of weir, the result obtained in table must be multiplied by the number of inches of breadth the weir may be. For example, suppose the notch or weir be 20 inches wide, and the water at stake E 5½ inches deep; in the first or last column find the figure 5, follow the horizontal column until the perpendicular column is reached containing ½ at the top. In the square where these two columns meet will be found 5.18 (five and eighteen-hundredths) cubic feet. This is the quantity of water that will pass for each inch in width; but, since the supposed weir was 20 inches wide, this result must be multiplied by 20, which gives 103.6 (one hundred and three and six-tenths) cubic feet per minute. In this manner the water passing any width of weir, of any depth from one-sixteenth of an inch to twenty-five inches depth, can be easily calculated.

The above table for weir measurement of water may be calculated by the following approximate formula, where

Q.—Quantity in cubic feet per minute, for every inch length of weir when contraction of area is reckoned at .62% of full area; and

H.—Height of water level over weir in inches (or over stake E in cut).

$$Q = .4\ h \sqrt{h} = \frac{4\ h \sqrt{h}}{10}$$

When the height *h* is fluctuating during the measurement, it will not be correct to take the average of h, but the average of the value $h \sqrt{h}$.

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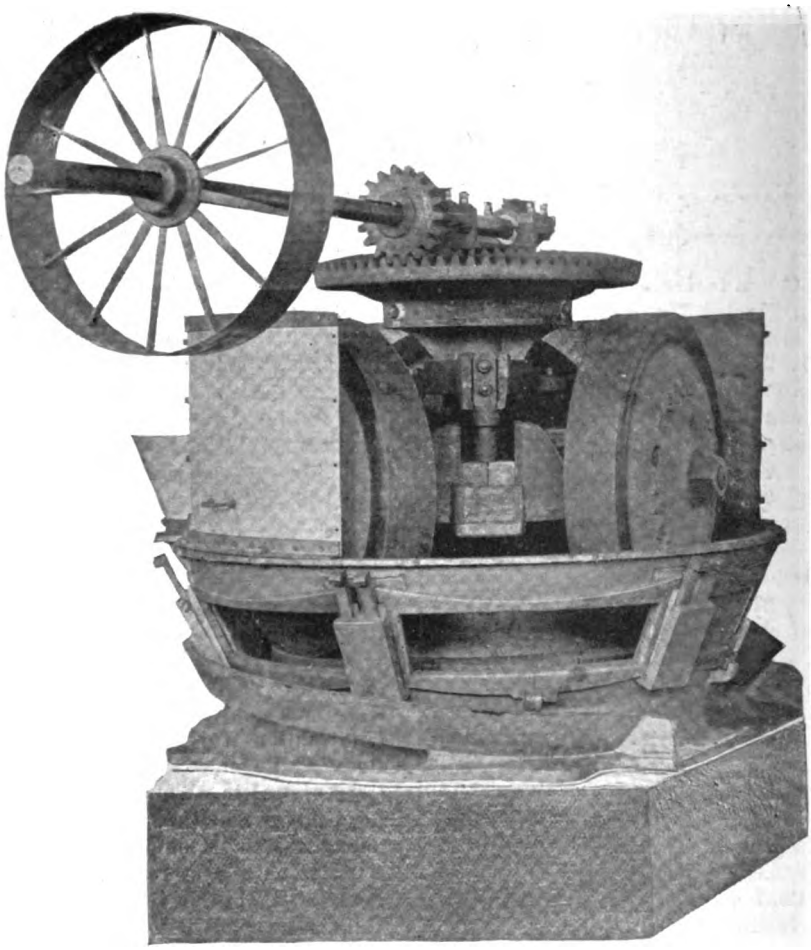
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In order to meet this demand we have, at a great expense, procured special hydraulic machinery, including multiple punches and hydraulic riveters, giving us the most complete and extensive plant in the country for this class of work.

We have given considerable attention to the manufacture of piping for use in the irrigation districts.

The construction and laying of pipe for purposes of town water supply we have developed into a special feature.

We have filled the largest contracts ever awarded on this coast for the manufacture and laying of water mains.

For the Spring Valley Water Company alone we have completed over 100 miles of water conduct of large size, several miles of which lay under 60 feet of water in the bay of San Francisco.

The filling of our contract required over 16,000 tons of plate iron and rivets.

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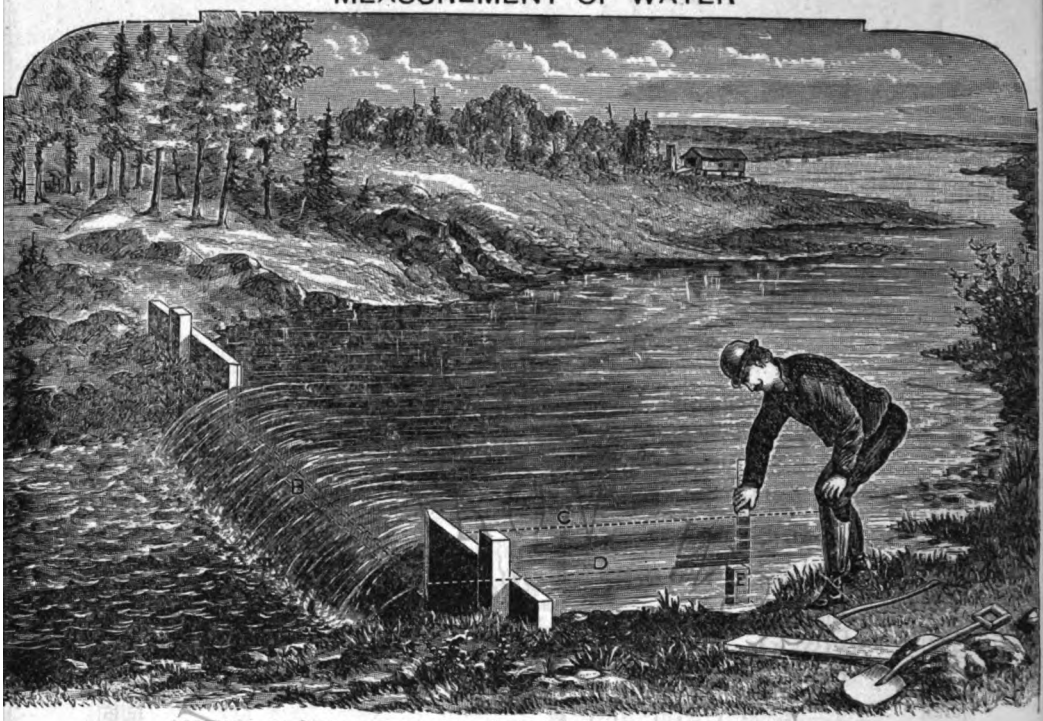
Will be found under appropriate heads for ready reference and the calculation of the various problems that present themselves from time to time in the study and practice of Hydraulics.

Information of a more definite character beyond the limits of this book we shall at all times cheerfully furnish, and invite correspondence in relation thereto.

Net prices will be quoted on application.

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MEASUREMENT OF WATER



WEIR DAM FOR MEASUREMENT OF WATER

WEIR TABLE FROM ONE-SIXTEENTH INCH DEPTH TO TWENTY-FIVE INCHES DEPTH.

Inches.		1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16		Inches.
		.006	.01	.03	.05	.07	.09	.11	.14	.17	.20	.23	.26	.30	.33	.36		
1	.40	.43	.47	.51	.55	.60	.65	.70	.74	.78	.83	.87	.93	.98	1.03	1.08	.40	1
2	1.14	1.19	1.24	1.30	1.36	1.41	1.47	1.52	1.59	1.65	1.71	1.77	1.83	1.89	1.96	2.02	1.14	2
3	2.09	2.16	2.23	2.29	2.36	2.43	2.50	2.57	2.63	2.71	2.78	2.85	2.92	2.99	3.07	3.14	2.09	3
4	3.22	3.29	3.37	3.44	3.52	3.60	3 68	3.75	3.83	3.91	3.99	4.07	4.16	4.24	4.32	4.41	3.22	4
5	4.50	4.58	4.67	4.75	4.84	4.92	5.01	5.10	5.18	5.27	5.36	5.45	5.54	5.63	5.72	5.81	4.50	5
6	5.90	6.00	6.09	6.18	6.28	6.37	6.47	6.56	6 65	6.75	6.85	6.95	7.05	7.15	7.25	7.35	5.90	6
7	7.44	7.54	7.64	7.74	7.84	7.94	8.05	8.15	8.25	8.35	8.45	8.55	8.66	8.76	8.86	8.97	7.44	7
8	9.10	9.20	9.31	9.42	9.52	9.63	9.74	9.85	9.96	10.07	10.18	10.29	10.40	10.51	10.62	10.73	9.10	8
9	10.86	10.97	11.08	11.19	11.31	11.42	11.54	11.65	11.77	11.88	12.00	12.12	12.23	12.35	12.47	12.59	10.86	9
10	12.71	12.83	13.95	13.07	13.19	13.31	13.43	13.55	13.67	13.80	13.93	14.04	14.16	14.30	14.42	14.55	12.71	10
11	14.67	14.79	14.92	15.05	15.18	15 30	15.43	15.56	15.67	15.81	15.96	16.08	16.20	16.34	16.46	16.59	14.67	11
12	16.73	16.86	16.99	17.12	17.26	17.39	17.52	17.65	17.78	17.91	18.05	18.18	18.32	18.45	18.58	18.72	16.73	12
13	18.87	19.01	19.14	19.28	19.42	19.55	19.69	19.83	19.97	20.10	20.24	20.38	20.52	20.66	20.80	20.94	18.87	13
14	21.09	21.23	21 37	21.48	21.65	21.79	21.94	22.08	22.22	22.35	22.51	22.65	22.79	22.94	23.08	23.23	21.09	14
15	23.38	23.53	23.67	23.82	23.97	24.11	24.26	24.41	24.56	24.71	24.86	25.01	25.16	25.31	25.46	25.61	23.38	15
16	25.76	25.91	26.06	26.21	26.36	26.51	26.66	26.81	26.97	27.12	27.27	27.43	27.58	27.73	27.89	28.04	25.76	16
17	28.20	28.35	28.51	28.66	28 82	28.98	29.14	29.29	29.45	29.60	29.76	29.92	30.08	30.23	30.39	30.55	28.20	17
18	30.70	30.86	31.02	31.18	31.34	31.50	31.66	31.81	31.98	32.15	32.31	32.47	32.63	32.80	32.96	33.12	30.70	18
19	33.29	33.45	33.61	33.78	33.94	34.11	34.27	34.44	34.60	34.77	34.94	35.10	35.27	35.44	35.6	35.77	33.29	19
20	35.94	36.10	36.27	34.46	36.60	37.87	36.94	37.11	37.28	37.45	37.62	37.79	37.96	38.14	38.31	38 48	35.94	20
21	38.65	38.82	39.00	39.17	39.34	39.52	39.60	39.86	40.04	40.21	40.39	40.56	40.73	40.91	41.09	41.26	38.65	21
22	41.43	41.60	41.78	41.96	42.13	42.31	42.49	42.67	42.84	43 02	43.20	43.38	43.56	43.74	43.92	44.10	41.43	22
23	44.28	44.46	44.64	44.82	45.00	45.18	45.38	45.53	45.71	45.90	46.08	46.26	46.43	46.63	46.81	47.00	44.28	23
24	47.18	47.36	47.55	47.72	47.91	48.09	48.28	48.46	48.65	48.83	49.02	49.20	49.39	49·58	49.76	49.93	47.18	24

Table gives cubic feet per min. for every inch in breadth of Weir.

MEASUREMENT OF WATER AND DESCRIPTION OF WEIR DAM

When a man has concluded to improve a water power, the first thing he should ascertain is the amount of head and fall he can secure. The next, and most important step, is to determine accurately the quantity of water that flows in the stream (provided there is a limited supply), as upon this will depend the amount of power, and consequently the amount of work the stream is capable of performing. And as the improvement of water power is necessarily attended with expense, it is therefore important to one who contemplates building a mill or factory, that he should know exactly what amount of work he can depend upon the stream doing; as, for the want of an accurate knowledge, or from an erroneous supposition of the quantity of water in the stream, parties frequently construct mills and factories of a magnitude which upon trial, is found to be entirely out of proportion to the power of the stream, and it fails to drive their machinery. Such being often the case, it is important, when practicable, to get some one well versed in hydraulics to measure the capacity of the stream. As this cannot always be done, we give herewith a few plain suggestions and illustrations, by the aid of which any one can determine approximately the quantity of water in a stream.

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The plate represents a weir dam across a small stream. Where it is convenient to use a single board, as shown in the cut, select one that is long enough to reach across the stream, resting in the bank at each end. Cut a notch in the board sufficient in depth to pass all the water to be measured, and not more than two-thirds of the width of the stream in length. The bottom of notch B in the board A should be beveled on the down-stream side; the ends of the notch should also be beveled on the same side, and within one-eighth of an inch of the upper side of the board, leaving the edge almost sharp. E is a stake driven in the bottom of stream several feet above the board or dam, and should be driven down to the level of notch B, this level being easily found as the water is beginning to spill over the board. After the water has come to a stand and reached its greatest depth, a careful measurement can be made of the depth of water over the top of stake E, as illustrated in the cut by the man with square and measure in hand. Such measurement gives the true depth of water passing over the notch, since, if measured directly on the notch or the board, the curvature of the water in passing would reduce the depth, giving the improper measure. Although, where accuracy is not required, such a method will give a fair estimate of the quantity of water; in all cases it is best to make the measurement over the stake. The line D is a level from the bottom of notch B to the top of stake E; while the dotted line C represents the top of the water, and the distance between the *lines* or from the top of stake, gives the *true depth* or spill over the weir. The lines have, in the cut, the appearance of running over the top of the board; but this is owing to the fact that they pass behind it, and, for the purpose of illustration, the reader is supposed to look through the board and the post. The surface of the water below the board should not be nearer the notch B than ten inches, that the flow of water over the notch may not be impeded. Neither should the nature of the channel above the board be such as to force or hurry the water to the board, but it should be of ample width and depth to allow the water to approach the notch and board steadily and quietly. If the water passes the channel rapidly it will be forced over the notch, and a larger quantity will pass than if allowed to spill from a large body moving slowly.

When the depth of water over the stake E is known, the quantity of water passing can be easily calculated by reference to the Weir Table on opposite page. This table gives the number of cubic feet of water passing per minute over a weir for each inch in breadth, from one-sixteenth of an inch in depth to twenty-five inches depth. The figures, 1, 2, 3, etc., in the first and last perpendicular columns, are the inches depth of water over weir, while the first or top horizontal column represents fractional parts of an inch, from one-sixteenth to sixteen-sixteenths. The body of the table shows the cubic feet and decimal parts of a cubic foot that will pass each minute for each depth of weir, from one-sixteenth to twenty-five inches, as before stated. But each result is for but one inch in width; so, for any particular number of inches breadth of weir the result obtained in table must be multiplied by the number of inches of breadth the weir may be. For example, suppose the notch or weir be 20 inches wide, and the water at stake E 5½ inches deep; in the first or last column find the figure 5, follow the horizontal column until the perpendicular column is reached containing ½ at the top. In the square where these two columns meet will be found 5.18 (five and eighteenth hundredths) cubic feet. This is the quantity of water that will pass for each inch in width; but since the supposed weir was 20 inches wide, this result must be multiplied by 20, which gives 103.6 (one hundred and three and six tenths) cubic feet per minute. In this manner the water passing any width of weir, of any depth from one-sixteenth of an inch to twenty-five inches depth can be easily calculated.

The above table for weir measurement of water may be calculated by the following approximate formula, where

Q—Quantity in cu. ft. per min., for every in. length of weir when contraction of area is reckoned at .62% of full area; and

H—Height of water level over weir in inches (or over stake E in cut).

$$Q = .4\ h\ \sqrt{h} = \frac{4\ h\ \sqrt{h}}{10}$$

When the height *h* is fluctuating during the measurement, it will not be correct to take the average of h, but the average of the value $h\sqrt{h}$.

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SHEET IRON AND STEEL

WATER PIPES.

EXPLANATION OF PIPE TABLES

The Tables for Sheet Iron Pipe, on pages 9, 10, 11 and 12, are arranged as follows:

COLUMN No. 1

Gives the diameter of the pipe in inches.

COLUMN No. 2

Is the area in square inches corresponding to the diameter.

COLUMN No. 3

Is the thickness of the iron or steel in decimal parts of an inch.

COLUMN No. 4

Is the thickness of the iron or steel by the Birmingham wire gauge.

COLUMN No. 5

Is the working pressure the pipe will be subjected to in pounds per square inch, allowing 10,000 pounds tensile strain per sectional inch of iron, deducting 25 per cent for riveted joints.

For Steel Pipes use 14,000 pounds tensile strain per sectional inch, deduct 25 per per cent for riveted joints. Hence, *working pressure for steel pipe* may be taken 40 per cent higher than given in table.

COLUMN No 6

Is the number of cubic feet of water that will flow through the pipe in one minute, when the velocity of the water is 10 feet per second.

COLUMN No. 7

Is an approximation of the weight of a lineal foot of pipe, including rivets.

The cost of pipe varies with the iron market, and the quantity ordered of one diameter and thickness—small lots costing sometimes 50 per cent more than large orders.

We charge extra for dipping pipes in asphaltum—coating them inside and outside—and the cost of dipping small pipes is about one cent for each inch in diameter and one foot in length.

Coating with asphaltum adds about one-third of a pound per square foot to the weight of the pipe.

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Diameter of Pipe.	Area of Pipe.	Thickness of Iron in inches.	Thickness of Iron by Wire Gauge.	Pressure the Pipe will stand.	Cub. ft. discharged per minute at a velocity of 10 ft. per second.	Weight of Pipe per lineal foot.	
1	2	3	4	5	6	7	8
3	7	0.035	20	176	29	1½	
3	7	0.049	18	245	29	2¼	
4	12.5	0.049	18	183	52	3	
4	12.5	0.065	16	243	52	4	
5	19.6	0.049	18	147	81	3½	
5	19.6	0.065	16	195	81	5	
5	19.6	0.083	14	249	81	6¼	
5	19.6	0.109	12	327	81	8½	
6	28	.049	18	122	116	4¼	
6	28	.065	16	162	116	5¾	
6	28	.083	14	207	116	7⅛	
6	28	.109	12	272	116	10	
7	38	.049	18	105	158	5¼	
7	38	.065	16	141	158	6¾	
7	38	.083	14	178	158	8½	
7	38	.109	12	234	158	11½	
8	50	.065	16	119	208	7½	
8	50	.083	14	155	208	9½	
8	50	.109	12	204	208	13	
8	63	.049	18	81	262	6¾	
9	63	.065	16	108	262	8¼	
9	63	.083	14	138	262	10¾	
9	63	.109	12	182		14¼	
9	63	.120	11	200	262	16	
9	63	.134	10	228	262	17½	
10	78	.065	16	98	313	9¼	
10	78	.083	14	125	313	11⅞	
10	78	.109	12	164	313	15¾	
10	78	.120	11		313	17¼	
10	78	.134	10	201	313	19¼	
11	95	.065	16	89	378	9¾	
11	95	.083	14	113	378	13	
11	95	.109	12	149	378	17¼	
11	95	.120	11	162	378	18⅜	
11	95	.134	10	183	378	21	
12	113	.065	16	81	470	11¼	
12	113	.083	14	104	470	14	
12	113	.109	12	130	470	17¾	
12	113	.120	11	144	470	19¾	
12	113	.134	10	160	470	22¾	
12	113	.165	8	206	470	27¾	
12	113	.180	7	225	470	32	
12	113	.203	6	254	470	36	
12	113	.238	4	297	470	41½	
13	132	.065	16	75	550	12	
13	132	.083	14	93	550	15	
13	132	.109	12	114	550	20	
13	132	.120	11	138	550	22	
13	132	.134	10	155	550	24½	
13	132	.165	8	190	550	30	
13	132	.180	7	207	550	34½	
13	132	.203	6	234	550	38½	
13	132	238	4	275	550	42½	
14	153	.065	16	69	637	13	
14	153	.083	14	89	637	16	
14	153	.109	12	117	637	21½	

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Diameter of Pipe.	Area of Pipe.	Thickness of Iron in inches.	Thickness of Iron by Wire Gauge.	Pressure the Pipe will stand	Cub. ft. discharged per minute at a velocity of 10 ft. per second.	Weight of Pipe per lineal foot.	
1	2	3	4	5	6	7	8
14	153	.120	11	129	637	23½	
14	153	.134	10	144	637	26	
14	153	.165	8	177	637	32	
14	153	.180	7	193	637	37	
14	153	.203	6	217	637	41¼	
14	153	.238	4	255	637	48	
15	176	.065	16	65	733	13¾	
15	176	.083	14	83	733	17	
15	176	.109	12	109	733	23	
15	176	.120	11	120	733	24½	
15	176	.134	10	134	733	28	
15	176	.165	8	165	733	34½	
15	176	.180	7	180	733	39	
15	176	.203	6	203	733	43¾	
15	176	.238	4	238	733	51	
16	201	.065	16	61	837	14½	
16	201	.083	14	78	837	17¾	
16	201	.109	12	102	837	24¼	
16	201	.120	11	113	837	26½	
16	201	.134	10	126	837	29½	
16	201	.165	8	155	837	36	
16	201	.180	7	169	837	41½	
16	201	.203	6	190	837	48¼	
16	201	.238	4	223	837	54½	
18	254	.065	16	54	1058	16½	
18	254	.083	14	69	1058	20⅓	
18	254	.109	12	91	1058	27¼	
18	254	.120	11	100	1058	30	
18	254	.134	10	111	1058	34	
18	254	.165	8	138	1058	41	
18	254	.180	7	150	1058	46	
18	254	.203	6	169	1058	51½	
18	254	.238	4	198	1058	60	
20	314	.065	16	40	1308	18	
20	314	.083	14	63	1308	22½	
20	314	.109	12	82	1308	30	
20	314	.120	11	90	1308	32½	
20	314	.134	10	101	1308	36½	
20	314	.165	8	124	1308	44½	
20	314	.180	7	135	1308	50¾	
20	314	.203	6	153	1308	56¾	
20	314	.238	4	179	1308	66	
22	380	.065	16	45	1583	20	
22	380	.083	14	57	1583	24¾	
22	380	.100	12	75	1583	32¾	
22	380	.120	11	82	1583	35¾	
22	380	.134	10	91	1583	40	
22	380	.165	8	112	1583	48¾	
22	380	.180	7	123	1583	51	
22	380	.203	6	138	1583	62	
22	380	.238	4	162	1583	72	
24	452	.083	14	52	1883	27¼	
24	452	.100	12	68	1883	35½	
24	452	.120	11	75	1883	39	
24	452	.134	10	84	1883	43¼	
24	452	.165	8	103	1883	53	
24	452	.180	7	112	1883	60	

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Diameter of Pipe.	Area of Pipe.	Thickness of Iron in inches.	Thickness of Iron by Wire Gauge.	Pressure the Pipe will stand.	Cub. ft. discharged per minute at a velocity of 10 ft. per second.	Weight of Pipe per lineal foot.	
1	2	3	4	5	6	7	8
24	452	.203	6	127	1883	67¼	
24	452	.238	4	149	1883	78¼	
26	530	.083	14	48	2208	29½	
26	530	.109	12	63	2208	38½	
26	530	.120	11	69	2208	42	
26	530	.134	10	78	2208	47	
26	530	.165	8	95	2208	57¼	
26	530	.180	7	104	2208	64¾	
26	530	.203	6	117	2208	72½	
26	530	.238	4	138	2208	84	
28	615	.083	14	45	2562	31¼	
28	615	.109	12	58	2562	41¼	
28	615	.120	11	64	2562	45	
28	615	.134	10	72	2562	50¼	
28	615	.165	8	88	2562	61¼	
28	615	.180	7	96	2562	69½	
28	615	.203	6	108	2562	77½	
28	615	.238	4	127	2562	90½	
30	706	.109	12	54	2941	44	
30	706	.120	11	60	2941	48	
30	706	.134	10	67	2941	54	
30	706	.165	8	82	2941	65	
30	706	.180	7	90	2941	74	
30	706	.203	6	102	2941	83	
30	706	.238	4	119	2941	96	
30	706	.250	¼	125	2941	101	
33	855	.120	11	54	3561	53	
33	855	.134	10	61	3561	59	
33	855	.165	8	75	3561	72	
33	855	.180	7	82	3561	81	
33	855	.203	6	93	3561	90	
33	855	.238	4	108	3561	105	
33	855	.250	¼	113	3561	110	
33	855	.259	3	118	3561	115	
33	855	.3125	5/16	142	3561	141	
36	1017	.120	11	50	4236	58	
36	1017	.134	10	56	4236	67	
36	1017	.165	8	69	4236	78	
36	1017	.180	7	75	4236	88	
36	1017	.203	6	84	4236	98	
36	1017	.238	4	92	4236	114	
36	1017	.250	¼	104	4236	120	
36	1017	.259	3	108	4236	125	
36	1017	.3125	5/16	130	4236	153	
36	1017	.375	3/8	156	4236	186	
40	1256	.134	10	51	5232	71	
40	1256	.165	8	62	5232	86	
40	1256	.180	7	68	5232	97	
40	1256	.203	6	76	5232	108	
40	1256	.238	4	90	5232	126	
40	1256	.250	¼	94	5232	132	
40	1256	.259	3	97	5232	138	
40	1256	.3125	5/16	117	5232	169	
40	1256	.375	3/8	141	5232	205	
42	1385	.134	10	48	5769	74½	
42	1385	.165	8	59	5769	91	
42	1385	.180	7	64	5769	102	

MISSISSIPPI RIVER COMMISSION

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Diameter of Pipe. 1	Area of Pipe. 2	Thickness of Iron in inches. 3	Thickness of Iron by Wire Gauge. 4	Pressure the Pipe will stand. 5	Cub. ft. discharged per minute at a velocity of 10 ft. per second. 6	Weight of Pipe per lineal foot. 7	8
42	1385	.203	6	72	5769	114	
42	1385	.238	4	85	5769	133	
42	1385	.250	1/4	89	5769	137	
42	1385	.259	3	92	5769	145	
42	1385	.3125	5/16	111	5769	177	
42	1385	.375	3/8	134	5769	216	
44	1520	.134	10	45	6332	78	
44	1520	.165	8	56	6332	95	
44	1520	.180	7	61	6332	106	
44	1520	.203	6	69	6332	119	
44	1520	.238	4	81	6332	139	
44	1520	.250	1/4	85	6332	145	
44	1520	.259	3	88	6332	151	
44	1520	.3125	5/16	106	6332	185	
44	1520	.375	3/8	128	6332	225	
48	1809	.134	10	42	7536	85	
48	1809	.165	8	51	7536	103	
48	1809	.180	7	56	7536	116	
48	1809	.203	6	63	7536	130	

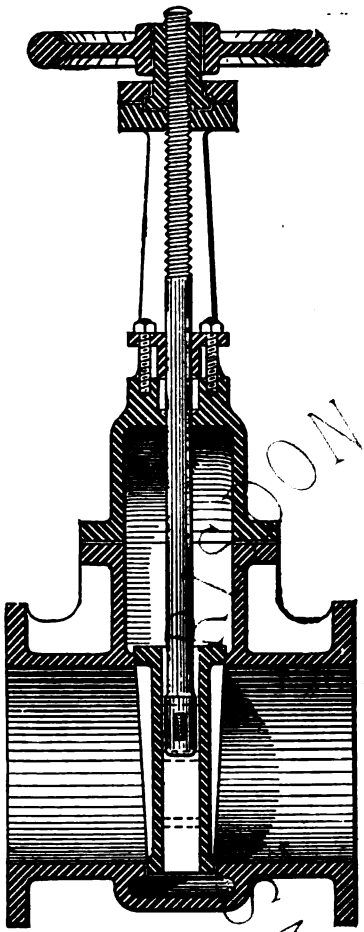
Diameter of Pipe. 1	Area of Pipe. 2	Thickness of Iron in inches. 3	Thickness of Iron by Wire Gauge. 4	Pressure the Pipe will stand. 5	Cub. ft. discharged per minute at a velocity of 10 ft. per second. 6	Weight of Pipe per lineal foot. 7	8
48	1809	.238	4	75	7536	151	
48	1809	.250	1/4	78	7536	158	
48	1809	.259	3	81	7536	164	
48	1809	.3125	5/16	98	7536	210	
48	1809	.375	3/8	117	7536	245	

Diameter of Pipe. 1	Area of Pipe. 2	Thickness of Iron in inches. 3	Thickness of Iron by Wire Gauge. 4	Pressure the Pipe will stand. 5	Cub. ft. discharged per minute at a velocity of 10 ft. per second. 6	Weight of Pipe per lineal foot. 7	8

RISDON IRON WORKS SAN FRANCISCO

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WATER GATES



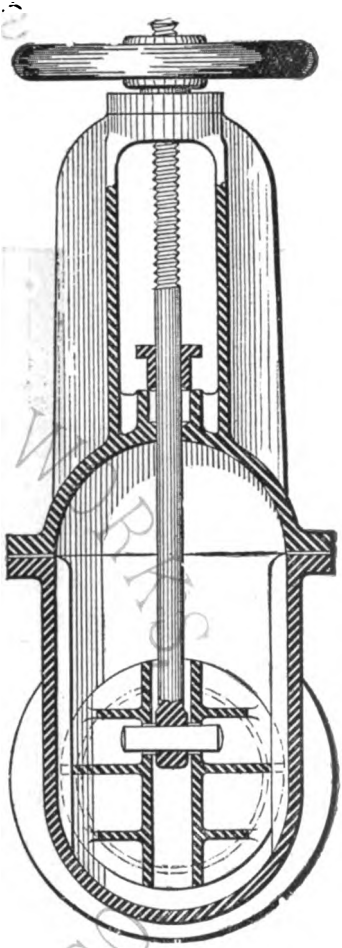
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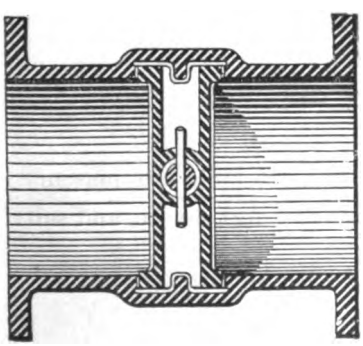
Both Light and Heavy Service.

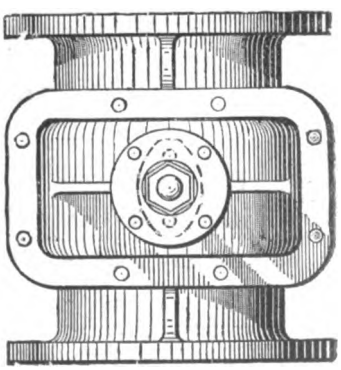
No.	Diam. of Gate	Weight	Price
7	7 in.	300	$ 45 00
9	9 "	400	65 00
11	11 "	500	75 00
12	12 "	700	85 00
13	13 "	800	90 00
15	15 "	1,050	100 00
16	16 "	1,200	120 00
18	18 "	1,550	150 00



NET PRICES FOR GATES FOR ANY SERVICE

QUOTED ON APPLICATION





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SLUICE GATE

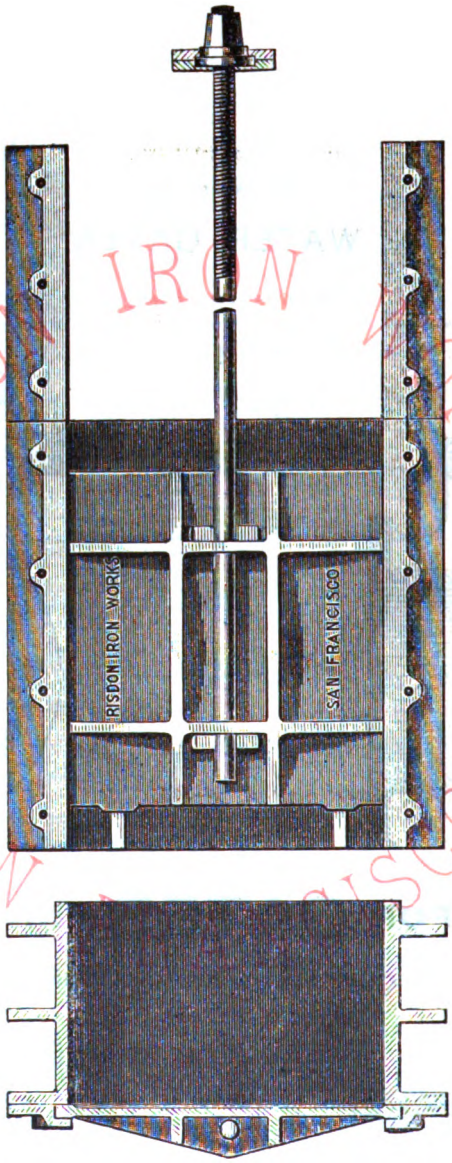
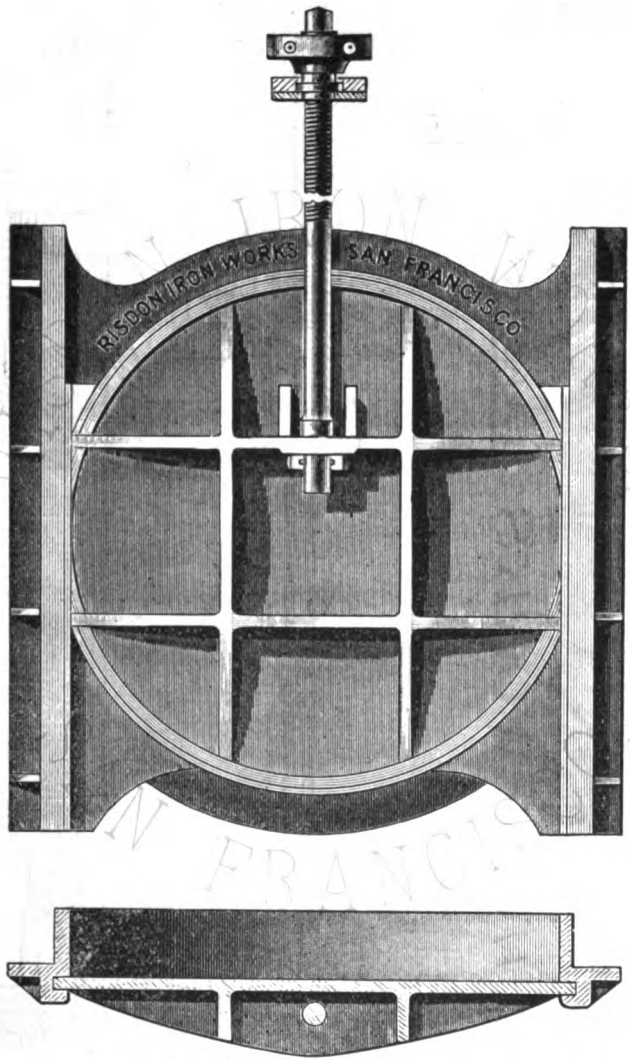


Plate represents Sluice Gate with cast-iron frame to build into masonry. We make these Gates with openings from 18 inches to 7 feet square, and suitable for any head of water.

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SLUICE GATE



The above illustration represents our Sluice Gate with guides suitable for bolting on to wood work. We make these Sluice Gates with openings 18 inches square up to 7 feet square ; and suitable for any head of water.

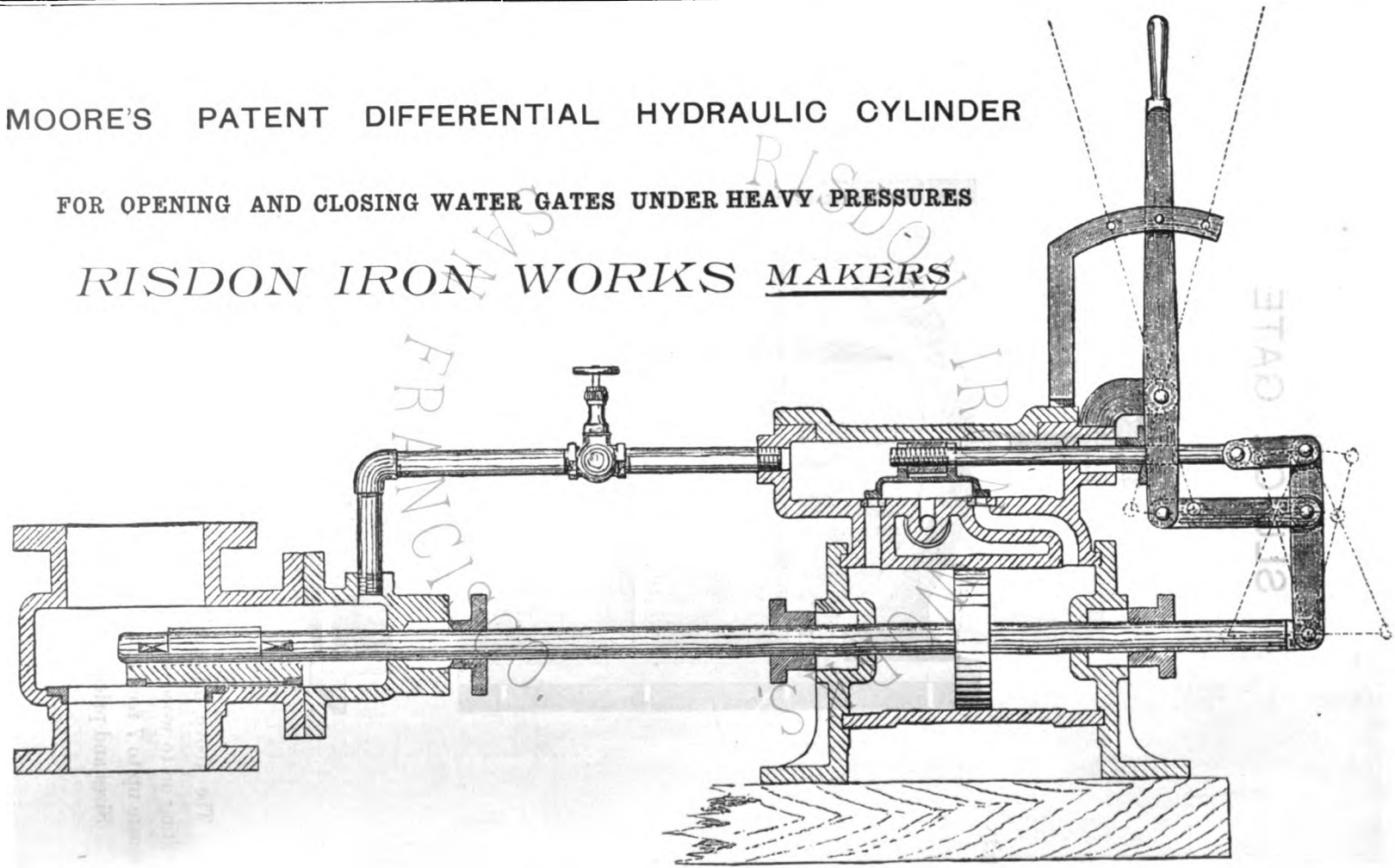
Sizes and prices on application.

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MOORE'S PATENT DIFFERENTIAL HYDRAULIC CYLINDER

FOR OPENING AND CLOSING WATER GATES UNDER HEAVY PRESSURES

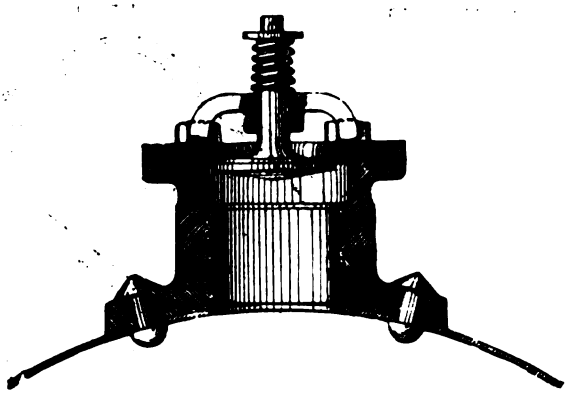
RISDON IRON WORKS MAKERS

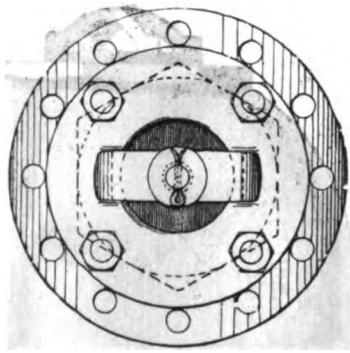


ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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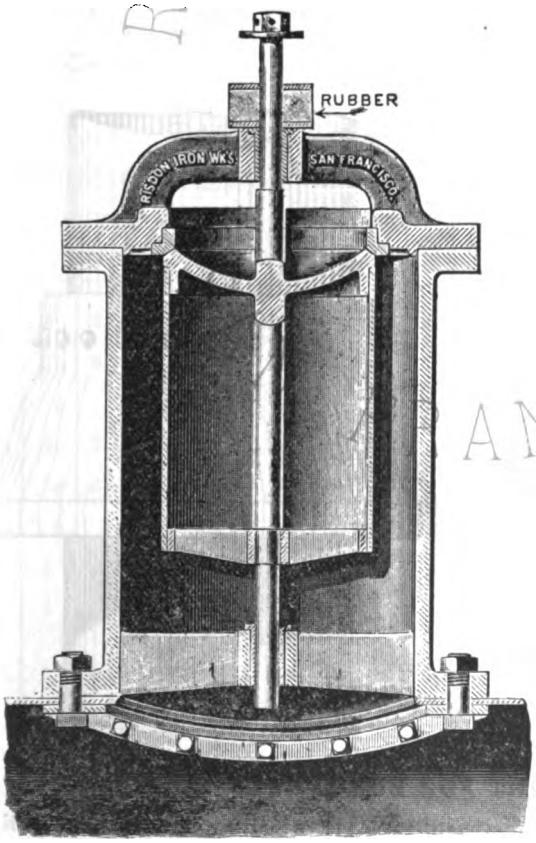
AIR ESCAPE VALVE





Air is apt to collect generally at high points of curves along water pipes, and unless removed produces more or less obstruction to the flow of water. For the prevention of this we manufacture an

AUTOMATIC AIR ESCAPE VALVE PLATE



AIR VALVE

THIS SIMPLE DEVICE

Consists of a cast-iron disc connected to the main pipe. At the top of the cover there is an opening for the escape of the air from within. In the disc is a float which has a guided stem, which allows the float to rise and fall freely without moving sideways. A Valve is attached to the upper end of the stem, which covers the air outlet, closing as soon as the water comes up to the float.

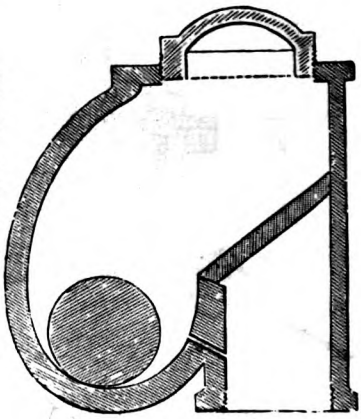
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CHABOT PATENT AUTOMATIC AIR VALVES

Fig. 28 — For Water Pipes — Fig. 29

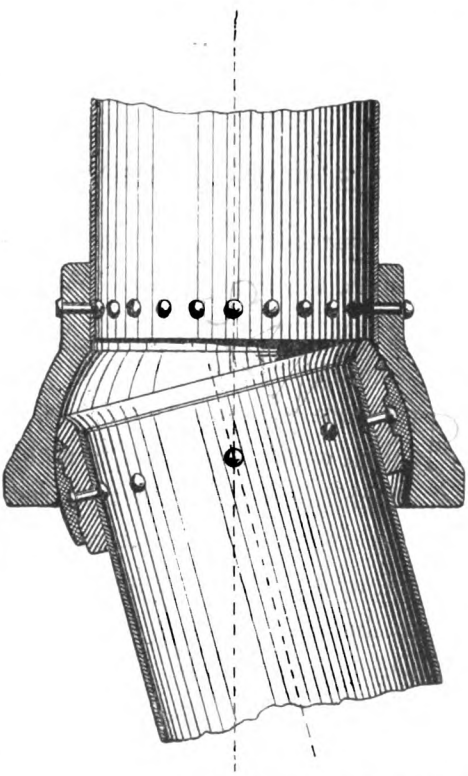


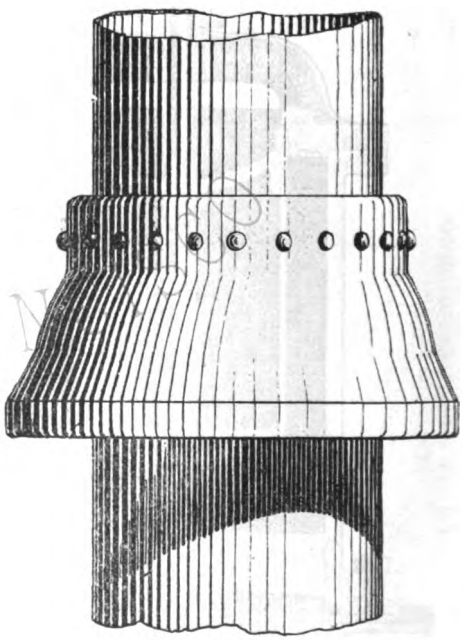
Size, inches.	Price each.
¾	$3.50
1	4.00
1¼	5.00
1½	7.00
2	10.00



PATENT FLEXIBLE BALL JOINT

As Used for Pipe Line laid under the Bay of San Francisco between Dumbarton Point and Menlo Park by the Risdon Iron Works.





PATENT BALL JOINT FOR SUBMERGED PIPE

The above illustration shows the Ball Joint as it was constructed for joints in a double line of 16-inch diameter pipe, 16,000 feet long, laid across and under the Bay of San Francisco, between Dumbarton Point and Menlo Park, for the City Water Works.

The deepest part of the bay at this point is over 50 feet, and the undertaking entailed considerable risk owing to strong tides and occasional heavy swells.

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FIG 4

STANDARD PIPE FLANGE

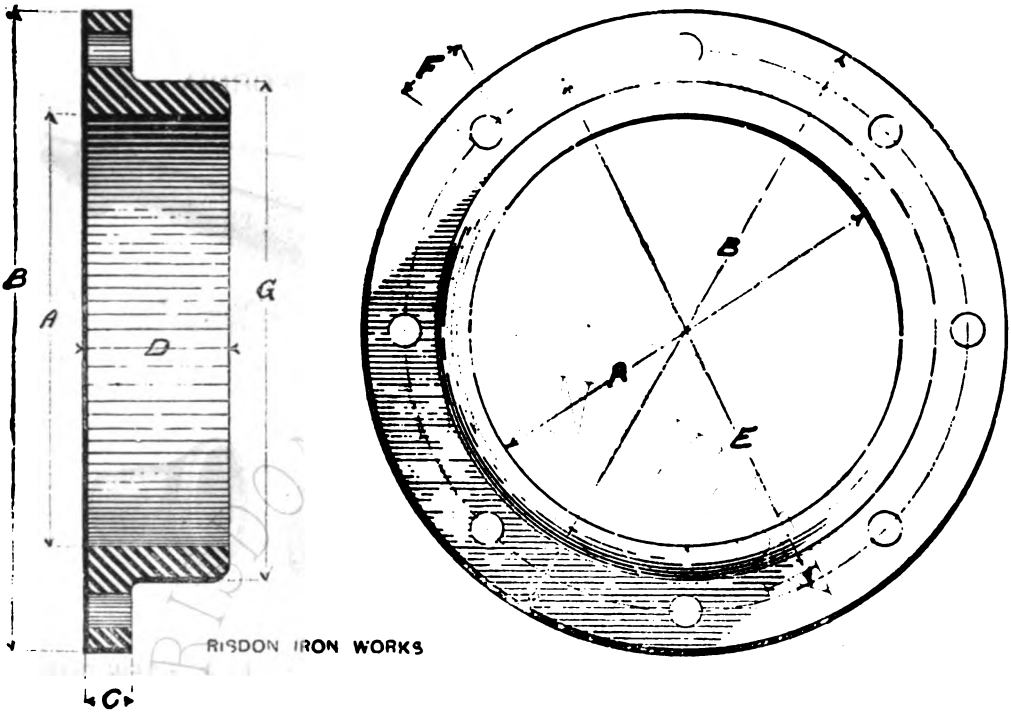


TABLE FOR ORDINARY FLANGES.

The size of the flange is designated by the size of the hole that fits on the pipe,

	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
A	3	3½	4	4½	5	5½	6	7	8	9	10	11	12	13	14	15	16	17	18	20
B	7½	8	8⅝	9⅛	9¾	10¾	10⅞	12⅜	13½	14½	15¾	17½	18½	19½	21¼	22½	24	25	26	28¼
C	⅝	⅝	11/16	11/16	¾	¾	13/16	13/16	⅞	⅞	1	1⅛	1¼	1¼	1⅜	1⅜	1½	1½	1⅝	1⅝
D	2	2	2⅛	2⅛	2¼	2¼	2⅜	2⅜	2½	2½	2¾	2⅞	3	3	3⅜	3½	3¾	3⅞	4⅛	4¼
E	5¾	6¼	6⅞	7⅜	8	8½	9⅛	10⅝	11½	12½	13¾	15	16¼	17¼	18¾	19¾	21¼	22¼	23¼	25½
F	⅝	⅝	⅝	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	⅞	⅞	⅞	1	1	1⅛	1⅛	1⅛	1⅛
G	4	4½	5⅛	5⅝	6¼	6¾	7⅞	8⅞	9½	10½	11¾	12¾	14	15	16¼	17¼	18½	19½	20½	22¾
N	4	4	4	6	6	6	6	8	8	8	8	8	8	10	10	10	10	10	10	12
Wgt.	8	9	11	12	15	16	21	26	29	32	43	55	67	71	96	107	124	142	161	190
Prce																				

☞ In ordering Flanges, please state which kind is desired. Also, if they are to be screwed, shrunk or riveted on the pipe. Then fill in the following dimensions, as indicated by letters in Fig. 4:

A—Is the diameter of hole in flange.
B—Is the outside diameter of the flange.
C—Is the thickness of the flange.
D—Is the depth of the flange where it fits the pipe.
E—Is the bolt circle.
F—Is the diameter of bolts.
G—Is the diameter of neck.
N—Gives the number of bolts.

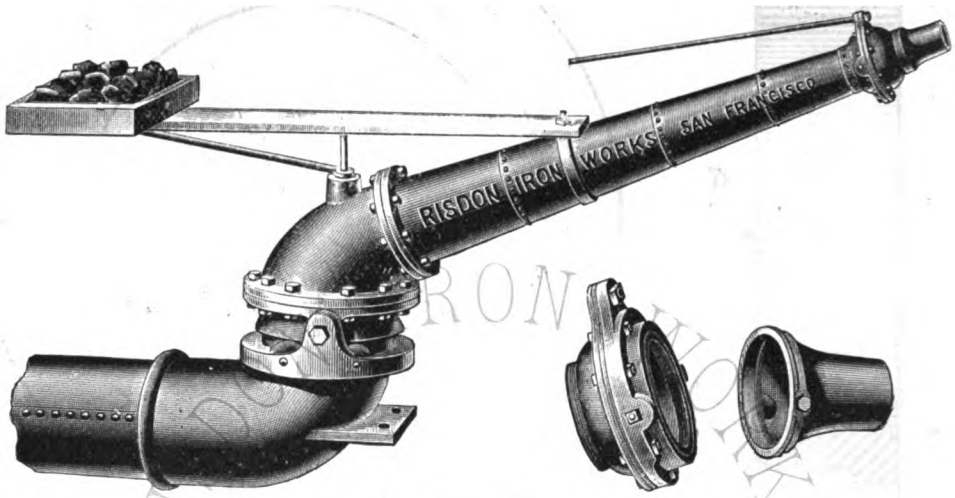
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IMPROVED FORM OF

HYDRAULIC GIANTS

AS USED IN THE

HYDRAULIC GRAVEL MINES OF CALIFORNIA



"HOSKINS"

We desire to call the attention of miners to our new hydraulic machine, or **NEW GIANT**, which is the best machine ever offered. We have dispensed with the center bolt, used in the old style, and which was so liable to catch trash.

There is a clear waterway through, and the capacity as to No. of size is also greatly increased. The horizontal and vertical motions are made with only one joint, and that a very durable one, and easily kept in order. The weight is reduced about 20 per cent, thus lessening the cost of transportation, and without decreasing the strength. This style of machine is also the easiest to work of any yet tried.

In this machine there would be a tendency in the discharge pipe to rear up. This is counteracted by the peculiar way in which the nozzle butt is attached to the pipe.

There is a notch on the flange of the pipe, and its counterpart on the flange of elbow; these should be matched when set up, and the pipe will usually be found self-balanced.

Sometimes where a large machine is used with a small nozzle and under low pressure the pipe may be inclined to drop; if so, reverse the notches, turning the pipe upside down; if that does not answer, apply the balance as shown in cut.

The Deflector is a valuable adjunct to all hydraulic machines. With it much more work is accomplished and with much less labor.

Suppose it takes a force of one hundred pounds applied at the end of discharge pipe to rotate the machine—this is heavy work for the pipeman and he moves the pipe by jerks, and with difficulty getting the stream to strike the bank just where he wishes it. With the Deflector, ten pounds force at the end of lever will move the pipe in any direction with the greatest facility and the stream can be directed to any point with certainty; a rock pile can be stirred up or a sand streak followed and all operations accomplished with perfect ease.

Double the work is accomplished when a Deflector is used.

CASH PRICES OF GIANTS

With each Giant we furnish two nozzles as per size ordered. The largest size should be at least ¼ of an inch smaller than the nozzle butt.

No.	Inlet.	Nozzle Butt.	Weight, about	Price.
1	7	4	200 lbs	$ 75.00
2	9	5	360 lbs	100 00
3	11	6	610 lbs	125.00
4	13	7	675 lbs	175.00
5	15	8	770 lbs	225 00
6	18	9	1200 lbs	350.00
7	24	10	1500 lbs	470.00

Larger sizes made to order. Reasonable charges for extra work.

We can supply Deflectors at manufacturers' prices. These are great labor-saving appliances. With the aid of a Deflector a child can manipulate the largest size machine. They are applied as shown in the cut.

CASH PRICES OF DEFLECTORS

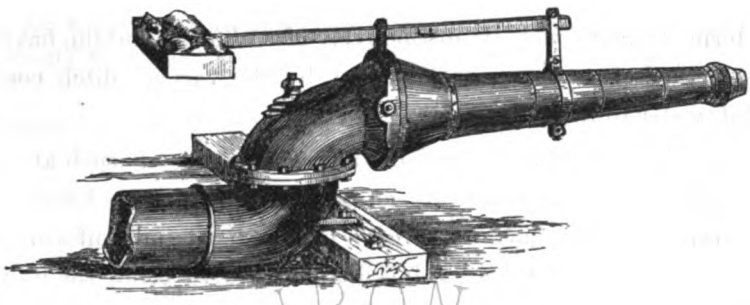
Size, inches....	4	5	6	7	8	9	10
Price.....	$50 00	55 00	60 00	65 00	70 00	75 00	80 00
Weight, lbs....	30	40	45	55	70	85	110

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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. We Also . Sell the

FISHER GIANT



CENTER BOLT MACHINE

While we recommend the Hoskins Giant because of its superiority in not having a center bolt, some miners insist on using this style of machine; and we will furnish them at the following prices:

Nos.	Inlets	Outlets	Diameter of Nozzle Butts Inside	Sizes Nozzles	Weights	PRICES
	Inches	Inches	Inches	Inches	Lbs.	
1	7	5½	4	2 and 3	420	$125 00
2	9	7	5	3 and 4	520	175 00
3	11	7½	6	3 and 4	825	225 00
4	11	9½	7	4 and 6	1075	250 00
5	13	9½	8	5 and 6	1350	300 00
6	15	9½	9	6 and 7	1600	350 00
7	15	11	10	6 and 7	1850	400 00
8	18	11	10	7 and 8	1950	450 00

The Deflectors on other page will suit these Giants.

All sizes of Water Gates, Elevators, Water Lifters and Sheet Iron and Steel Riveted Water Pipe manufactured to order.

ADDRESS ALL COMMUNICATIONS TO

RISDON IRON & LOCOMOTIVE WORKS

San Francisco, Cal.

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A "MINER'S INCH" OF WATER.

The term "miner's inch" is distinctively of California origin, having grown out of the method of measurement adopted by the various ditch companies in disposing of water to their customers.

A miner's inch of water varies in different localities to such an extent that it may almost be said to constitute an arbitrary quantity. Efforts have been made from time to time to make a miner's inch a fixed and uniform quantity of water. For various reasons this has failed, and we give below the measurements used by the principal ditch companies of California.

MEASUREMENT OF WATER BY DIFFERENT DITCH COMPANIES IN CALIFORNIA

DITCH COMPANIES	Opening Inches.	Pressure Board, Inches.	Mean Pressure Inches.	Cubic Feet.
Amador Canal Co	2	4	5	1.40
Eureka Lake and Canal Co	2	5	6	1.45
Park Canal and Mining Co	2	5	6	1.45
Eldorado Water and Deep Gravel Mining Co	4	4	6	1.45
Mok. and Campo Seco Canal and Mining Co	4	3	5	1.40
Union Water Co., Murphy's	4	4	6	1.45
South Yuba Canal Co	4	4	6	1.45
North Bloomfield	2	6	7	1.60
Milton	2	6	7	1.60
La Grange	2	6	7	1.60
Smartsville Ditch Co	4	7	9	1.78

The North Bloomfield, Milton and La Grange companies measure through a 3-inch plank, the others use 1 and 1½-inch planks.

FOR USUAL CALCULATIONS

A flow of one Miner's Inch of water is equal to the supply of

	Gallons.	Cubic Feet.
Per second	.1875	.025
Per minute	11.25	1.5
Per hour	675.	90.00
Per day	162.0.	2160.

Or a flow of one cubic foot

Per second equals 40 miner's inches.

Per minute equals $\frac{2}{3}$ miner's inches.

Per hour equals .01110+ miner's inches.

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TABLE

SHOWING THE DISCHARGE IN CUBIC FEET PER MINUTE OF A MINER'S INCH OF WATER AS MEASURED UNDER THE VARIOUS HEADS AND DIFFERENT LENGTHS AND HEIGHTHS OF APERTURES USED IN CALIFORNIA.

Length of Opening in Inches.	Opening 2 Inches High.			Opening 4 Inches High.		
	Head to Center 5 Inches.	Head to Center 6 Inches.	Head to Center 7 Inches.	Head to Center 5 Inches.	Head to Center 6 Inches.	Head to Center 7 Inches.
	Cubic Feet.	Cubic Feet.	Cubic Feet	Cubic Feet.	Cubic Feet.	Cubic Feet.
4	1.348	1.473	1.589	1.320	1.450	1.570
6	1.355	1.480	1.596	1.336	1.470	1.595
8	1.359	1.484	1.600	1.344	1.481	1.608
10	1.361	1.485	1.602	1.349	1.487	1.615
12	1.363	1.487	1.604	1.352	1.491	1.620
14	1.364	1.488	1.604	1.354	1.494	1.623
16	1.365	1.489	1.605	1.356	1.496	1.626
18	1.365	1.489	1.606	1.357	1.498	1.628
20	1.365	1.490	1.606	1.359	1.499	1.630
22	1.366	1.490	1.607	1.359	1.500	1.631
24	1.366	1.490	1.607	1.360	1.501	1.632
26	1.366	1.490	1.607	1.361	1.502	1.633
28	1.367	1.491	1.607	1.361	1.503	1.634
30	1.367	1 491	1.608	1.362	1.503	1.635
40	1.367	1.492	1 608	1.363	1.505	1.637
50	1.368	1.493	1.609	1.364	1.507	1.639
60	1.368	1.493	1.609	1.365	1.508	1.640
70	1.368	1.493	1.609	1.365	1.508	1.641
80	1.368	1.493	1.609	1.366	1.509	1.641
90	1.369	1.493	1.610	1.366	1.509	1.641
100	1 369	1.494	1.610	1.366	1.509	1.642

The above measurements of water were obtained by a series of very careful experiments, made by W. F. Englebright and L. A. Pelton, at Nevada City, Cal. The apertures were through material 1¼ inch thick, and their lower edge 2 inches above the bottom of the measuring box, thus giving full contraction.

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HYDRAULICS.

TABLES AND THEIR USES

The following Tables by which any one, however unskilled, is unabled at a glance to solve many of the more difficult and important problems in hydraulics, have been computed from a large amount of data obtained by the most careful experiments of the ablest engineers. It is, therefore, with assurance that these tables are commended as the most simple and reliable of any extant.

FLOW OF WATER THROUGH RECTANGULAR ORIFICES IN THIN VERTICAL PARTITIONS

Question—The head being ten feet, and the gate-opening being six inches high and one foot wide, what will be the discharge in miners' inches?

Answer—In this table, opposite 10 *feet* in first column, find in column headed "6 inches high, 1 foot wide," 7.62 cubic feet. Multiply this number by 50, the number of miners' inches in one cubic foot, and there results 762×50=381.00 miners' inches.

Question—The head being twenty-five feet, and the opening one and five-tenths inches high, one foot wide, how many pounds will be discharged per second?

Answer—In this table, opposite 25 feet in first column find in column headed "1.5 inches high, 1 foot wide," 3.05 cubic feet. Multiply this number by 62.5, the number of pounds in a cubic foot. 3.05×62.5=190 625 pounds.

Question—The head being seven feet, and the opening one inch high, one foot wide, what will be the discharge in cubic feet?

Answer—In this Table, opposite 7 feet in first column, find in column headed 3 inches high, 1 foot wide, 3.24 cubic feet. The given height 1 inch is one third of 3 inches, the height of the opening; hence, without sensible error, we may take one-third the flow due 3 inches for that opening. 3.24÷3=1.08.

FLOW OF WATER OVER WEIRS PER SECOND FOR EACH FOOT IN LENGTH OF WEIR

Question—The head from still water being 8.4 inches, what is the flow for one foot in length over weir?

Answer—In the third column of this Table is found the given head 8.4 inches, opposite which in the fourth column find 1.96 cubic feet, the required flow.

Question—The head from still water being 2 feet 6 inches, what is the flow in miners' inches over 1 foot length of weir?

Answer—In the fifth column of this Table is found 2.6 the given head, opposite which in column six will be found 13.167 cubic feet flow per second. This multiplied by 50, the number of miners' inches in one cubic foot flow per second, gives 13.167×50=658.35 miners' inches.

FLOW OF WATER THROUGH CLEAN IRON PIPES

REMARKS.—In the analysis of the flow of water, the total head is divided into three parts, viz: 1st, that portion of the head due to the velocity; 2d, that portion which overcomes the resistance of entry; and 3d, that portion which overcomes the resistance within the pipe. In long pipes, the two former portions as compared with the latter portion of the total head are quite small. In this Table the greatest velocity in any pipe is 13.445 feet per second, due to 4.2 feet, the sum of the first and second portions of the total head, while the third portion of the head is 211.2 feet. The head or fall in this Table refers to the third portion of the total head. This Table has been computed on the assumption that the length of any pipe is not less than 1,000 times its diameter.

Question—The fall being 52.8 feet per mile, what will be the flow through a pipe 22 inches diameter, in cubic feet, also in miners' inches?

Answer—In this Table find in first column 52.8 feet, opposite which in column headed 22 inches will be found the required quantity, viz: 21.06 cubic feet, which multiplied by 50, gives 1,053 miners' inches.

Question—The diameter of the pipe being 24 inches, what fall will be required for the pipe to carry 1,000 miners' inches?

Answer—In this Table, in column headed 24 inches, find that number which multiplied by 50 will make the 1,000 miners' inches given. In this case, the nearest number is 20.42, opposite which in column headed fall per mile will be found 31.68 feet, the fall required.

Question—In carrying 1,050 inches of water to a hydraulic mine in a pipe 27 inches diameter, having a fall of 95.04 feet to the mile, what will be the effective head at the mine?

Answer—In this Table, in column headed 27 inches, find that number which multiplied by 50 will make 1,050 approximate miners' inches. In this case, we have 21.13 cubic feet, opposite which in column headed fall per mile, we find 18.48 feet, which is the head per mile lost in carrying the water. Subtracting this from the given fall or head, gives the effective head. Thus 95.04—18.48=76.56 feet effective head.

Question—There being 7.5 gallons in a cubic foot, and 86,400 seconds in a day (twenty-four hours,) the fall 7.39 feet per mile, how many gallons will a pipe 40 inches diameter carry per day?

Answer—In this Table, in column headed 40 inches and opposite 7.39 feet headed fall per mile, will be found 37.57 cubic feet flow per second. Then 37.57×7.5×86,400=24,345,360 gallons.

GENERAL RULE—The velocity per second is equal to 50 times the square root of the product of the head and diameter in feet, divided by the sum of the length and 50 times the diameter of the pipe in feet.

SHORT PIPES—This rule applies to both long and short pipes, and is approximately accurate if the diameter does not exceed two feet.

ADDITIONAL HEAD NECESSARY TO OVERCOME THE RESISTANCE OF ONE CIRCULAR BEND

Question—The radius of the pipe being to the radius of the bend in the ratio of 1:5, the number of degrees in the bend being 90°, and the velocity 75 feet per second, what is the additional head required to overcome the resistance of the bend?

Answer—In this Table, in first column headed velocity per second, find 75 feet, opposite which in column headed 1:5 90° is found 6.03 feet, the required head.

Question—The radius of the pipe being to the radius of the bend in the ratio of 2:5, the number of degrees in the bend being 120°, and the velocity per second 100 feet, what is the additional head required to overcome the resistance of one bend?

Answer—In this Table opposite 100 feet velocity will be found in column headed 2:5, 120° the required number, viz: 21.34 feet.

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ADDITIONAL HEAD REQUIRED TO OVERCOME ONE ANGULAR BEND

Question:—The velocity being 40 feet per second, what additional head is required to overcome the resistance of an angular bend whose angle of deflection is 90 degrees?

Answer:—In this table find in column headed velocity per second 40, opposite which in column headed "90 degrees *head*," will be found 24.45 feet, the additional head required.

FLOW OF WATER THROUGH NOZZLES

Question:—The head being 125 feet, how many cubic feet per sesond will a nozzle 4 inches in diameter discharge? How many miners' inches?

Answer:—In this table find in the first column the given head 125 feet, opposite which in column headed four inches will be found the required quantity, viz: 7.28 cubic feet and 7.28x50=364 *miners' inches.*

Question:—Between the inlet and the nozzles of a hydraulic pipe 3 feet in diameter, the distance is five miles and the total fall 275 feet. The pipe is to carry 2,000 miners' inches of water, which is to be discharged through two "Little Giants," or nozzles equal in size. What will be the loss of head by the resistance in the main pipe? What will be the size of each nozzle?

Answer:—In table showing Flow of Water through Clean Iron Pipes find in column headed 36 inches that number which multiplied by 50 will make 2.000, the given number of *miners' inches*. In this case, 40.86 approximates sufficiently near, opposite which in column headed fall per mile is found 14.78 feet, the loss of head per mile. Multiply this by 5, the length of the pipe, and we have 14.78×5=73.9 feet, the loss of resistance in the pipe 5 miles long. Subtracting this from the total head, 275−73.9=201.1 feet remaining head. Again, in same table find 200 nearest 201.1 feet in column headed "head," opposite which in column headed "6 inches," is found 20.64, which multiplied by 50 gives 1,032, or approximately 1,000 miners' inches, which each nozzle is required to discharge. Hence, the nozzles are to be 6 inches in diameter each.

RELATION OF CLEAN, SLIGHTLY ROUGH AND VERY ROUGH PIPES WITH RESPECT TO THEIR CARRYING CAPACITY

CLEAN PIPES.—The tables, as appear by the headings, have been computed for clean pipes, in other words, smooth and straight.

SLIGHTLY ROUGH PIPES.—When the pipe is slightly rough multiply the tabulated number for clean pipes by the decimal .886 to determine its carrying capacity.

VERY ROUGH PIPES.—If the pipe is *very rough* multiply the tabulated number for clean pipes by the decimal .773 to determine its carrying capacity.

RELATION OF THE INLET FORMS OF PIPES WITH RESPECT TO THE CO-EFFICIENTS OF ENTRANCE

CO-EFFICIENTS—Of the three following forms, viz: *Bell Mouthed, Square Edged* and *Sguare Edged* projecting into the reservoir, their co-efficients will be in order .900, .836 and .734.

FLOW OF WATER IN OPEN CHANNELS, BASE TO PERPENDICULAR OF SIDE SLOPE BEING AS 3:4

Question:—The dimensions of a canal being top width, 11 feet; bottom width, 5 feet, depth, 4 feet, and the fall per mile, 8 feet. Required the number of inches, miners' measure; that it will carry.

Answer:—In this table, in column headed "fall per mile," find 8 feet opposite which in column headed with given specifications (11, 5, 4,) is found 104.8 cubic feet, the flow per second. This multiplied by 50, the number of miners' inches equal to one cubic foot flow per second, gives 104.8×50=5,240 miners' inches required.

FLOW OF WATER IN OPEN CHANNELS, BASE TO PERPENDICULAR OF SIDE SLOPE BEING AS 2:1

Question:—Required the number of cubic feet of water that will flow in a canal whose top width is 40 feet; bottom width, 20 feet; depth, 5 feet, and whose fall is 2 feet per mile.

Answer:—In this table, in column "fall per mile," find two feet, opposite which in column headed with the given specifications (40, 20, 5,) is found the required flow, viz: 376.1 cubic feet.

RELATIVE CARRYING CAPACITY OF OPEN CHANNELS WHOSE SECTIONAL AREAS ARE EQUAL TO EACH BUT OF DIFFERENT FORMS

The form in which the bottom width is made equal to one of the sides, and in which the base to the perpendicular of the side slope is as 3:4, has been adopted as the standard form when the ground will admit, it being the simplest of construction.

The relative carrying capacity for trapezoidal form, base : depth of slope : : 3 : 4 ; bottom width : depth : : 5 : 4. Co-efficient of capacity, 1,000.

Trapezoidal, form, base : depth of slope : : 1 : 1 ; bottom width = depth, .994.

Flume, 2 : 1, .961; semi-hexagonal, 1.008; square, .925; semi-circular, 1.056.

Question:—The fall being 6 feet per mile, the sectional area of a *square flume* 8 square feet, what will be its carrying capacity per second?

Answer:—In table showing Flow of Water in Open Channels, Base to Perpendicular of Side Slopes being as 3 : 4, in column of "fall per mile," find the given fall 6 feet, opposite which in column headed "sectn. 8.0 sq. ft.." is found 13.65 cubic feet. This multiplied by the co-efficient for a sq., viz: .965, gives 13.64×.925=12.63 cubic feet.

REMARKS.—The tables for the flow of water in open channels have been computed upon the assumption that the canals are smooth and straight.

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TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod Ft.	Fall Per Rod In.	Diameters. ½ in. Cu. ft.	¾ in. Cu. ft.	1 in. Cu. ft.	1½ in. Cu. ft.	1¾ in. Cu. ft.	2 in. Cu. ft.
21.12	0	0.792	.....	.....	.....	.....	.....	.02584
26.40	0	9.990	.....	.....	.....	.....	.02014	.02924
31.68	0	1.188	.....	.....	.....	.01460	.02270	.03274
36.96	0	1.396	.....	.....	.....	.01583	.02426	.03492
42.24	0	1.584	.....	.....	.00567	.01707	.02638	.03776
47.52	0	1.782	.....	.....	.00617	.01816	.02838	.04081
52.80	0	1.980	.....	.00316	.00677	.01963	.02988	.04321
63.36	0	2.376	.00122	.00350	.00781	.02123	.03260	.04843
73.92	0	2.772	.00124	.00377	.00841	.02282	.03556	.05150
84.48	0	3.168	.00135	.00411	.00886	.02466	.03706	.05456
95.04	0	3.564	.00143	.00445	.00961	.02577	.03923	.05740
105.60	0	3.960	.00150	.00466	.00990	.02793	.04224	.06111
158.40	0	5.940	.00197	.00589	.01245	.03458	.05175	.07399
211.20	0	7.920	.00241	.00705	.01492	.04132	.06167	.08734
264.00	0	9.900	.00279	.00798	.01666	.04577	.07145	.1095
316.80	0	11.880	.00315	.00874	.01857	.05043	.07830	.1200
369.60	1	1.86	.00340	.00951	.01988	.05424	.08381	.1283
422.40	1	3.84	.00366	.01012	.02141	.05804	.08949	.1375
475.20	1	5.82	.00389	.01086	.02283	.06191	.09400	.1442
528.00	1	7.80	.00410	.01144	.02424	.06724	.10030	.1523
633.00	1	11.76	.00453	.01282	.02676	.07400	.1110	.1634
739.20	2	3.72	.00473	.01380	.02890	.08020	.1200	.1748
844.00	2	7.68	.00524	.01480	.03081	.08622	.1285	.1855
950.40	2	11.64	.00559	.01567	.03276	.09225	.1372	.1955
1056.00	3	3.60	.00589	.01656	.03458	.09692	.1450	.2047
1320.00	4	1.50	.00660	.01871	.03897	.1079	.1617	.2276
1584.00	4	11.40	.00732	.02064	.04316	.1187	.1773	.2483
2112.00	6	7.20	.00855	.02390	.04987	.1380	.2050	.2833
2640.00	8	3.00	.00966	.02705	.05648	.1550	.....	.....
3168.00	9	10.80	.01065	.03003	.06320	.....	.....	.....
3696.00	11	6.60	.01156	.03301	.06943	.....	.....	.....
4224.00	13	2.40	.01248	.03572	.....	.....	.....	.....
4752.00	14	10.20	.01338	.03786	.....	.....	.....	.....
5280.00	16	5.00	.01419	.....	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod. Ft.	Fall Per Rod. In.	Diameters. 3 in. Cu. ft.	4 in. Cu. ft.	6 in. Cu. ft.	8 in. Cu. ft.	10 in. Cu. ft.	11 in. Cu. ft.	12 in. Cu. ft.
5.280	0	0.198	.....	.....	.....	.....	.....	.....	1.265
6.336	0	0.238	.....	.....	.....	.....	.878	1.120	1.402
7.392	0	0.277	.....	.....	.....	.....	.960	1.221	1.489
8.448	0	0.317	.....	.....	.....	573	1.047	1.320	1.634
9.504	0	0.356	.....	.....	.....	611	1.110	1.394	1.728
10.560	0	0.396	.....	.....	.298	639	1.194	1.490	1.826
11.616	0	0.436	.....	.....	.314	659	1.265	1.580	1.940
12.672	0	0.475	.....	.....	.330	703	1.325	1.653	2.026
13.728	0	0.515	.....	.1285	.346	737	1.377	1.722	2.117
14.784	0	0.554	.....	.1298	.359	763	1.423	1.788	2.207
15.840	0	0.594	.0630	.1335	.377	808	1.470	1.854	2.297
18.480	0	0.684	.0692	.1465	.395	876	1.587	1.996	2.466
21.120	0	0.792	.0749	.1562	.444	931	1.683	2.136	2.662
26.400	0	0.990	.0839	.1771	.496	1.045	1.865	2.397	3.020
31.680	0	1.188	.0915	.1923	.548	1.575	2.059	2.636	3.310
36.960	0	1.386	.0992	.2146	.589	1.202	2.222	2.858	3.601
42.240	0	1.584	.1060	.2339	.631	1.344	2.383	3.062	3.856
47.520	0	1.782	.1119	.2460	.672	1.424	2.514	3.232	4.072
52.800	0	1.980	.1190	.2582	.721	1.496	2.662	3.419	4.305
63.360	0	2.376	.1313	.2893	.784	1.644	2.932	3.760	4.728
73.920	0	2.772	.1413	.3036	.858	1.782	3.210	4.016	5.094
84.480	0	3.168	.1507	.3237	.922	1.916	3.450	4.390	5.482
95.040	0	3.564	.1590	.3412	975	2.033	3.679	4.679	5.839
105.600	0	3.960	.1717	.3607	1.022	2.155	3.856	5.251	6.160
158.400	0	5.940	.2081	.4503	1.263	2.667	4.762	6.086	7.630
211.200	0	7.920	.2469	.5331	1.484	3.145	5.563	7.022	8.860
264.000	0	9.900	.2785	.5954	1.665	3.513	6.704	8.244	9.967
316.800	0	11.880	.3049	.6390	1.929	3.847	.....	.....	.....
369.000	1	1.860	.3331	.6967	1.976	4.196	.....	.....	.....
422.400	1	3.840	.3559	.7506	2.144	.....	.....	.....	.....
475.200	1	5.820	.3816	.7960	2.274	.....	.....	.....	.....
528.000	1	7.800	.4043	.9464	2.399	.....	.....	.....	.....
633.600	1	11.760	.4440	.9270	.....	.....	.....	.....	.....
739.200	2	3.720	.4977	1.0060	.....	.....	.....	.....	.....
844.800	2	7.680	.5181	1.0810	.....	.....	.....	.....	.....
950.400	2	11.640	.5436	.....	.....	.....	.....	.....	.....
1056.000	3	3.600	.5832	.....	.....	.....	.....	.....	.....
1320.000	4	1.500	.6523	.....	.....	.....	.....	.....	.....
1584.000	4	11.400	.....	.....	.....	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per M Feet.	Fall Per R. Ft	Fall Per R. In	Diameters. 14 in. Cu. ft.	15 in. Cu. ft	16 in. Cu. ft.	18 in. Cu. ft.	20 in. Cu. ft.	22 in. Cu. ft.	24 in. Cu. ft.	27 in. Cu ft.
2.11	0	0.08	.....	.....	.....	.....	.....	.....	.....	.....
2.64	0	0.10	.....	.....	.....	.....	.....	.....	.....	8.27
3.17	0	0.12	.....	.....	.....	.....	3.61	4.61	6.10	8.87
3.70	0	0.14	.....	.....	2.25	3.10	4.07	5.25	6.64	9.09
4.22	0	0.16	1.71	2.05	2.43	3.27	4.35	5.62	7.13	9.48
4.75	0	0.18	1.83	2.19	2.59	3.49	4.68	6.01	7.56	10.26
5.28	0	0.20	1.91	2.30	2.72	3.66	4.92	6.32	7.95	10.74
5.81	0	0.22	2.02	2.43	2.88	3.88	5.15	6.62	8.34	11.45
6.34	0	0.24	2.11	2.54	3.02	4.06	5.40	6.94	8.75	11.93
6.86	0	0.26	2.18	2.65	3.18	4.23	5.62	7.24	9.14	12.54
7.39	0	0.28	2.27	2.75	3.28	4.40	5.82	7.51	9.47	12.96
7.92	0	0.30	2.35	2.84	3.39	4.61	6.05	7.78	9.80	13.49
8.45	0	0.32	2.44	2.94	3.49	4.75	6.27	8.03	10.13	13.98
8.98	0	0.34	2.54	2.98	3.62	4.90	6.48	8.36	10.57	14.41
9.50	0	0.36	2.59	3.11	3.69	5.03	6.65	8.55	10.77	14.81
10.03	0	0.38	2.67	3.21	3.81	5.17	6.92	8.85	11.10	15.21
10.56	0	0.40	2.72	3.29	3.92	5.30	7.05	9.07	11.43	15.63
11.62	0	0.44	2.88	3.47	4.12	5.63	7.42	9.55	12.05	16.44
12.67	0	0.48	3.02	3.63	4.32	5.87	7.79	10.01	12.61	17.23
13.73	0	0.51	3.15	3.79	4.51	6.18	8.14	10.48	13.23	18.01
14.78	0	0.55	3.29	3.95	4.68	6.38	8.48	10.91	13.79	18.75
15.84	0	0.59	3.42	4.11	4.87	6.64	8.77	11.29	14.25	19.50
18.48	0	0.69	3.62	4.46	5.31	7.17	9.49	12.25	15.50	21.13
21.12	0	0.79	3.99	4.78	5.67	7.65	10.16	13.12	16.62	22.62
26.40	0	0.99	4.46	5.37	6.39	8.66	11.43	14.78	18.71	25.34
31.68	0	1.19	4.91	5.91	7.02	9.54	12.59	16.20	20.42	27.74
36.96	0	1.39	5.37	6.45	7.66	10.33	13.66	17.53	22.05	29.96
42.24	0	1.59	5.77	6.90	8.16	11.09	14.66	18.78	23.61	31.90
47.52	0	1.78	6.11	7.31	8.64	11.71	15.54	19.93	25.07	33.97
52.80	0	1.98	6 44	7.70	9.10	12.37	16.47	21.06	26.42	35.89
63.36	0	2.38	7.00	8.39	9.95	13.65	17.99	23.07	29.03	39.76
73.92	0	2.77	7.60	9.15	10.87	14.75	19.49	24.68	31.49	43.22
84.48	0	3.17	8.17	9.81	11.63	15.84	21.03	26.97	33.90	46.57
95.04	0	3.56	8.93	10.47	12.43	16.90	22.45	29.70	36.18	48.06
105.60	0	3.96	9.26	11.09	13.14	17.85	23.56	31.15	38.45	.....
158.40	0	5.94	11.39	13.66	16.17	21.86	28.86	.....	.....	.....
211.20	0	7.92	13.22	15.84	18.77	.....	.....	.....	.....	.....

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TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod Ft.	Fall Per Rod In.	Diameters. 30 in. Cu. ft.	33 in. Cu. ft.	36 in. Cu. ft.	40 in. Cu. ft.	44 in. Cu. ft.	48 in. Cu. ft.
1.06	0	0.04	.....	.....	10.29	13.88	18.15	22.68
1.58	0	0.06	7.78	10.21	12.70	17.00	22.22	27.89
2.11	0	0.08	8.99	11.65	14.56	19.68	25.55	32.93
2.64	0	0.10	10.24	12.92	16.35	22.08	28.87	37.00
3.17	0	0.12	10.97	13.99	18.02	24.43	31.46	40.21
3.70	0	0.14	11.90	15.14	19.76	26.27	34.47	43.67
4.22	0	0.16	12.84	16.36	20.85	28.14	37.06	46.81
4.75	0	0.18	13.48	17.53	22.30	29.80	39.01	49.06
5.28	0	0.20	14.21	18.74	23.47	31.46	41.06	52.15
5.81	0	0.22	15.05	19.54	24.91	33.25	42.09	54.95
6.34	0	0.24	15.81	20.28	26.12	34 68	44.97	57.36
6.86	0	0.26	16.47	21.29	27.20	36.21	46 77	60.07
7.39	0	0.28	17.18	22.20	28.24	37.57	48.83	62.98
7.92	0	0.30	17.94	23.01	29.19	39 18	50.62	64.47
8.45	0	0.32	18.58	23.76	30.29	40.54	52.46	66.53
8.98	0	0.34	19.21	24.47	31.42	41.88	54.04	68.50
9.50	0	0.36	19.66	25.22	32.48	43.07	55.48	70.62
10.03	0	0.38	20.32	26.14	33.40	44.28	57.01	72.75
10.56	0	0.40	20.79	26.94	34.49	45.20	58.85	74.44
11.62	0	0.44	21.80	28.27	36.15	48.12	61.71	78.29
12.67	0	0.48	22.83	29.02	37.74	50.48	64.35	81.68
13.73	0	0.51	23.93	31.06	39.40	52.67	66.87	85.20
14.78	0	0.55	24.86	32.28	40.86	55.04	69.57	88.46
15.84	0	0.59	25.87	33.62	42.28	56.33	72.32	91.73
18.48	0	0.69	27.96	36.17	45.95	61.09	77.96	100.49
21.12	0	0.79	29.84	38.57	48.83	65.41	83.60	106.89
26.40	0	0.99	33.55	43.12	54.89	73.09	93.37	119.34
31.68	0	1.19	36.79	47.40	59.95	80.32	103.28	130.86
36.96	0	1.39	39.66	51.35	65.17	86.70	111.74	142.09
42.24	0	1.59	42.39	54.91	69.80	92.58	119.93	153.94
47.52	0	1.78	45.23	58.20	74.33	98.00	128.26	.....
52.80	0	1.98	47.71	61.62	78.46	103.99	.....	.....
63.36	0	2.38	52.91	68.00	82.84	.....	.....	.....
73.92	0	2.77	57.65	73.95	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND THROUGH CLEAN IRON PIPES.

Fall Per Mile Feet.	Fall Per Rod. Ft.	Fall Per Rod. In.	Diameters. 54 in. Cu. ft.	60 in. Cu. ft.	72 in. Cu. ft.	84 in. Cu. ft.	96 in. Cu. ft.
.53	0	0.02	21.96	29.77	46.99	75.43	107.77
1.06	0	0.04	31.70	38.19	57.65	104.61	152.45
1.58	0	0.06	38.58	52.09	82.53	126.18	188.45
2.11	0	0.08	45.12	59.04	95.99	145.43	218.75
2.64	0	0.10	50.23	67.56	109.42	162.75	245.30
3.17	0	0.12	55.51	74.32	121.58	177.03	267.41
3.70	0	0.14	60.21	80.51	132.04	192.04	290.53
4.22	0	0.16	63.61	86.30	139.96	207.81	310.89
4.75	0	0.18	67.20	91.99	148.72	222.44	324.20
5.28	0	0.20	72.37	96.98	157.77	235.13	350.45
5.81	0	0.22	75.71	102.39	165.97	253.34	366.19
6.34	0	0.24	79.13	107.31	178.04	264.77	382.02
6.86	0	0.26	82.54	115.53	179.26	275.16	397.85
7.39	0	0.28	85.90	116.53	187.46	287.67	414.70
7.92	0	0.30	89.52	119.63	193.93	296.37	427.76
8.45	0	0.32	92.43	123.70	200.18	307.87	443.09
8.98	0	0.34	95.35	127.63	206.40	316.15	457.42
9.50	0	0.36	97.55	131.26	212.06	326.73	470.49
10.03	0	0.38	100.19	134.79	217.71	336.79	481.53
10.56	0	0.40	103.82	138.84	225.21	348.25	496.37
11.62	0	0.44	108.78	145.98	235.52	364.92	522.76
12.67	0	0.48	113.47	152.56	246.41	339.09	547.88
13.73	0	0.51	118.48	158.65	256.17	394.43	570.01
14.78	0	0.55	123.10	164.54	267.19	408.36	592.13
15.84	0	0.59	128.19	170.43	277.88	428.86	612.00
18.48	0	0.69	138.92	183.93	299.72	462.99	.....
21.12	0	0.79	147 91	197.52	320.74	.....	.....
26.40	0	0.99	165.80	221.95	358.52	.....	.....
31.68	0	1.19	182.42	244.26	.....	.....	.....
36 96	0	1.39	190.01	.....	.....	.....	.....

TABLE SHOWING FLOW OF WATER PER SECOND OVER WEIRS, FOR EACH FOOT IN LENGTH OF WEIR.

Head from Still water Ft.	Head from Still water In.	Flow per S 1 ft. in lgt. Cu. Ft.	Head from Still water Ft.	Head from Still water In.	Flow per S 1 ft. in lgt. Cu. Ft.	Head from Still water Ft.	Head from Still water In.	Flow per S 1 ft. in lgt. Cu. Ft.
0	0.48	.026	0	5.52	1.090	1	2.4	4.390
0	0.60	.037	0	5.76	1.107	1	3.6	4.951
0	0.72	.048	0	6.00	1.177	1	4.8	5.531
0	0.84	.060	0	6.24	1.248	1	6.0	6 134
0	0.96	.074	0	6.48	1.321	1	7.2	6.756
0	1.08	.088	0	6.72	1.396	1	8.4	7 399
0	1.20	.104	0	6.96	1.472	1	9.6	8.052
0	1.32	.120	0	7.20	1.551	1	10.8	8.732
0	1.44	.137	0	7.44	1.629	2	0.0	9.430
0	1.56	.154	0	7.68	1.708	2	1.2	10.146
0	1.68	.172	0	7.92	1.789	2	2.4	10.869
0	1.80	.191	0	8.16	1.871	2	3.6	11.619
0	1.92	.210	0	8.40	1.960	2	4.8	12.385
0	2.04	.230	0	8.64	2.038	2	6.0	13 167
0	2.16	.251	0	8.88	2.124	2	7.2	13.966
0	2.28	.273	0	9.12	2.212	2	8.4	14.778
0	2.40	.296	0	9.36	2.300	2	9.6	15.607
0	2.64	.341	0	9.60	2.388	2	10.8	16.450
0	2.88	.388	0	9.84	2.479	3	0.0	17.309
0	3.12	.438	0	10.08	2.570	3	1.2	18.181
0	3.36	.489	0	10.32	2.662	3	2.9	19 068
0	3.60	.545	0	10.56	2.756	3	3.6	19.969
0	3.84	.593	0	10.80	2.850	3	4.8	20.795
0	4.08	.657	0	11.04	2.946	3	6.0	21.719
0	4.32	.716	0	11.28	3 043	3	7 2	22 657
0	4.56	.776	0	11 52	3 141	3	8.4	23.607
0	4.80	.838	0	11.76	3.240	3	9.6	24 571
0	5.04	.902	1	0.00	3.339	3	10 8	25.547
0	5.28	.972	1	1.20	3.862	4	0.0	26 536

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TABLE SHOWING FLOW OF WATER IN OPEN CHANNELS—

BASE TO PERPENDICULAR OF THE SIDE SLOPES BEING AS 3 : 4.

Fall per M'l. Ft.	Fall per Rod. In.	T 2.2 ft. B 1.0 ft D .8 ft Section 1.28 sq. ft. Cu. ft.	T 3.3 ft. B 1.5 ft D 1.2 ft Section 2.88 sq. ft. Cu. ft.	T 4.4 ft B 2.0 ft D 1.6 ft Section 5.12 sq. ft. Cu. ft	T 5.5 ft B 2.5 ft D 2.0 ft Section 8.0 sq. ft. Cu. ft.	T 6.6 ft B 3.0 ft D 2.4 ft Section 11.52 sq. ft. Cu. ft.	T 7.7 ft B 3.5 ft D 2.8 ft Section 15.68 sq. ft. Cu. ft.	T 8.8 ft B 4.0 ft D 3.2 ft Section 20.48 sq. ft. Cu. ft.
1	.0375	.45	1.33	2.67	5.57	9.05	13.46	20.28
2	.0750	.63	1.88	3.87	7.88	12.80	19.04	28.64
3	.1125	.77	2.30	4.74	9.65	15.67	23.32	35.08
4	.1500	.89	2.65	5.47	11.14	18.52	26.93	40.51
5	.1875	1.00	2.97	6.12	12.46	20.24	30.11	45.36
6	.2250	1.09	3.25	6.70	13.65	22.17	32.98	49.62
7	.2625	1.18	3.42	7.24	14.74	23.94	35.63	55.58
8	.3000	1.26	3.75	7.73	15.75	25.60	38.08	57.28
9	.3375	1.34	3.98	8.21	16.71	27.15	40.39	60.76
10	.3750	1.41	4.19	8.65	17.61	28.62	42.57	64.05
11	.4125	1.48	4.40	9.07	18.47	30.02	44.65	67.18
12	.4500	1.54	4.60	9.48	19.30	31.35	46.64	70.15
13	.4875	1.61	4.78	9.86	20.08	32.63	48.54	73.03
14	.5250	1.67	4.96	10.24	20.84	33.87	50.38	75.79
15	.5625	1.73	5.14	10.60	21.57	35.05	52.14	78.44
16	.6000	1.78	5.31	10.94	22.27	36.20	53 86	81.02
17	.6375	1.84	5.47	11.28	22.96	37.31	55.51	89.51
18	.6750	1.89	5.63	11.60	23.63	38.39	57 11	85.93
19	.7125	1.94	5.78	11 92	24.28	39.44	58.58	88.29
20	.7500	1.99	5.93	12.23	24.91	40.47	60.21	90.58
21	.7875	2.04	6.08	12.54	25.53	41.47	61.70	92.82
22	.8250	2.09	6.22	12.83	26.12	42.45	63.15	95.00
23	.8625	2.14	6.36	13.12	26.71	43.40	64.57	97.15
24	.9000	2.18	6.50	13.40	27.29	44.34	65.95	99.23
25	.9375	2.23	6.63	13.68	27.98	45.24	67.32	101.28

In Tables, T signifies top width ; B, bottom width ; D, depth.

TABLE SHOWING FLOW OF WATER IN OPEN CHANNELS—

BASE TO PERPENDICULAR OF THE SIDE SLOPES BEING AS 3 · 4.

Fall per M'l. Ft.	Fall per Rod. In.	T 9.9 ft B 4.5 ft D 3.6 ft Section 25.92 sq. ft. Cu. ft.	T 11. ft B 5. ft D 4. ft Section 32. sq. ft. Cu. ft.	T 13.2 ft B 6.0 ft D 4.8 ft Section 46.09 sq. ft. Cu. ft	T 16.4 ft B 7.0 ft D 5.6 ft Section 62.72 sq. ft. Cu. ft	T 17.6 ft B 8.0 ft D 6.4 ft Section 81.92 sq. ft. Cu. ft.	T 19.8 ft B 9.0 ft D 7.2 ft Section 103.68 sq. ft. Cu. ft.	T 22. ft B 10. ft D 8. ft Section 128. sq. ft Cu. ft
1	.0375	28.04	37.1	58.4	96.5	138.3	189.2	261.2
2	.0750	39.67	52.4	82.7	136.4	195.7	267.6	369.4
3	.1125	48.59	64.2	101.4	167.1	239.6	327.7	451.3
4	.1500	56.10	74.1	117.1	192.9	276.7	378.4	522.3
5	.1875	62.71	82.9	130.9	215.7	309.3	423.1	584.0
6	.2250	68.70	90.8	143.4	236.3	338.8	463.5	639.8
7	.2625	74.19	98.1	154.8	255.3	366.0	500.5	691.0
8	.3000	79.53	104.8	165.5	272.9	391.2	535.1	738.7
9	.3375	84.14	111.1	175.6	289.4	415.0	567.6	783.5
10	.3750	88.68	117.1	185.1	305.0	437.4	598.2	825.9
11	.4125	93.02	122.9	194.1	319.9	458.7	613.2	866.2
12	.4500	97.15	128.4	202.8	334.2	479.1	655.4	925.6
13	.4875	101.13	133.6	211.1	347.8	498.7	682.1	941.7
14	.5250	104.94	138.7	219.0	360.9	517.5	707.8	977.2
15	.5625	108.63	143.5	226.6	373.6	535.7	732.8	1011.5
16	.6000	112.18	148.2	234.1	385.9	553.3	756.7	1044.7
17	.6375	115.64	152.4	241.3	397.8	570.3	780.1	1076.9
18	.6750	118.99	157.2	248.3	409.3	586.9	802.7	1108.1
19	.7125	122.26	161.5	255.1	420.5	601.5	824.8	1138.4
20	.7500	125.43	165.7	261.7	431.4	618.5	846.1	1168.0
21	.7875	128.53	169.8	268.2	442.0	633.9	867.0	1196.8
22	.8250	131.55	173.8	274.5	452.5	648.8	887.4	1225.0
23	.8625	134.51	177.7	280.7	462.9	663.4	907.4	1252.6
24	.9000	137.40	181.5	286.7	472.6	677.7	926.0	1279.5
25	.9375	140.24	185.3	292.6	482.3	691.6	946.0	1306.0

In Tables, T signifies top width ; B, bottom width ; D, depth.

TABLE SHOWING FLOW OF WATER IN OPEN CHANNELS—

BASE TO PERPENDICULAR OF THE SIDE SLOPES BEING AS 2 : 1.

Fall per Mile. Feet.	Fall per Rod. Inches.	T 6. ft B 2. ft D 1. ft Section 4. sq. ft. Cu. ft.	T 9. ft B 3. ft D 1.5 ft Section 9. sq. ft. Cu. ft.	T 12. ft B 4. ft D 2. ft Section 16. sq. ft. Cu. ft.	T 16. ft B 6. ft D 2.5 ft Section 27.5 sq. ft. Cu. ft.	T 22. ft B 10. ft D 3. ft Section 48. sq. ft. Cu. ft.	T 28. ft B 12. ft D 4. ft Section 80. sq. ft. Cu. ft.	T 40. ft B 20. ft D 5. ft Section 150. sq. ft. Cu. ft.
.5	.01875	1.27	3.85	8.63	18.11	8.79	78.2	188.1
.6667	.0250	1.46	4.44	9.96	20.91	44.79	90.3	217.2
.8333	.03125	1.63	4.96	11.14	23.38	50.08	101.0	242.8
1.	.0375	1.79	5.44	12.20	25.61	54.86	110.6	266.0
1.25	.046875	2.00	6.08	13.64	28.68	61.32	123.7	297.4
1.5	.05625	2.19	6.67	14.96	21.34	67.26	135.7	326.1
1.75	.065625	2.37	7.19	16.14	33.88	72.57	146.4	351.8
2.	.0750	2.53	7.69	17.26	36.22	77.58	156.5	376.1
2.25	.084375	2.68	8.16	18.30	38.42	82.29	165 9	399.0
2.5	.09375	2.83	8.60	19.29	40.50	86.72	174.9	420.6
3.	.1125	3.10	9.42	21.14	44.36	95.00	191.6	460.7
3.5	.13125	3.35	10.17	22.83	47.91	102.6	207.0	497.6
4.	.1500	3.58	10.87	24.41	51.22	109.7	221.3	531.9
4.5	.16875	3.79	11.54	25.88	54.33	116.3	234.7	564.2
5.	.1875	4.00	12.16	27.29	57.27	122.7	247.4	594.8
6.	.2250	4.38	13.31	29.89	62.74	134.4	271.0	651.5
7.	.2625	4.73	14.39	32.29	67.79	145.1	292.7	703.6
8.	.3000	5.06	15.38	34.52	72.43	155.2	312.9	752.2
9.	.3375	5.37	16.31	36.61	76.83	164.6	331.9	797.9
10.	.3750	5.66	17 19	38.59	80.99	173.5	349.9	841.1
11.	.4125	5.93	18.03	40.47	84.94	181.9	366.9	882.1
12.	.4500	6.20	18.74	42.27	88.72	190.1	383.2	921.5

In Tables, T signifies top width ; B, bottom width, D, depth

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TABLE SHOWING ADDITIONAL HEAD REQUIRED TO OVERCOME THE RESISTANCE OF ONE CIRCULAR BEND.

Velocity per Sec. Feet.	Ratio of Radius of Pipe to Radius of Bend.									
	1 : 5 30° Head. Feet.	1 : 5 60 Head. Feet.	1 : 5 90° Head. Feet.	1 : 5 120° Head. Feet.	1 : 5 180° Head. Feet.	2 : 5 30° Head. Feet.	2 : 5 60° Head. Feet.	2 : 5 90° Head. Feet.	2 : 5 120° Head. Feet.	2 : 5 180° Head. Feet.
1	.0004	.0007	.0011	.0014	.0022	.0005	.001	.002	.002	.005
2	.0014	.0029	.0043	.0058	.0086	.0021	.004	.006	.008	.013
3	.0032	.0064	0096	.0128	.0192	.0048	.010	.014	.020	.029
4	.0057	.0114	.0171	.0228	.0342	.0085	.017	.025	.034	.051
5	.0089	.0179	.0268	.0358	.0536	.0133	.027	.040	.054	.080
6	.0129	.0257	.0386	.0514	.0772	.0192	.038	.058	.076	.115
7	.0175	.0350	.0525	.0700	.1050	.0261	052	.078	.104	.157
8	.0229	.0457	.0686	.0914	1372	.0341	.068	102	.136	.205
10	.0357	.0714	.1072	.1428	.2144	.0533	.107	160	.214	320
15	.0804	.1607	.2411	.3214	.4822	.1200	.240	.360	480	720
20	.1429	.2858	.4287	.5716	.8574	.2130	.426	.639	.852	1.28
25	.2232	.4464	.6696	.8928	1.34	.3333	667	1.00	1 33	2.00
30	.3214	.6428	.9642	1.29	1.93	.4798	960	1.44	1.92	2.88
40	.5714	1.14	1.71	2.28	3.42	.8530	1 71	2.56	3.42	5.12
50	.8927	1.79	2.68	3.58	5.36	1.33	2.66	3.99	5.32	7.98
75	2.01	4.02	6.03	8.04	12.06	3.00	6.00	9.00	12.00	18.00
100	3.57	7.14	10.71	14.28	21.42	5.33	10.67	15.99	21.34	31.98
150	8.04	16.07	24.11	32.14	48.22	12.00	24.00	36.00	48.00	72 00
200	14.29	28.58	42.87	57.16	85.74	21.32	42.64	63.96	127.92	127.92
300	32.14	64.28	96.42	128.56	192 84	47 98	95.96	143.94	287.88	287.88

TABLE SHOWING ADDITIONAL HEAD REQUIRED TO OVERCOME THE RESISTANCE OF ONE ANGULAR BEND.

Velocity Per Sec. Feet.	Angles of Deflection.						
	15° Head. Feet.	30° Head. Feet.	40° Head. Feet.	60° Head. Feet.	90° Head. Feet.	120° Head. Feet.	
1	.0002	.0005	.002	.006	.015	.029	
2	.0010	.0019	.009	.023	.061	.116	
3	.0022	.0042	.019	.051	.138	.260	
4	.004	.008	.035	.090	.245	.462	
5	.006	.012	.054	.141	.382	.723	
6	.009	.017	.078	.204	.550	1.04	
7	.012	.023	.106	.277	.749	1.42	
8	.016	.030	.138	.362	.978	1.85	
10	.025	.047	.216	.565	1.53	2.89	
15	.056	.105	.486	1.27	3.44	6.50	
20	.099	.186	.863	2.26	4.85	11.56	
25	155	.291	1.35	4.45	9.55	18.06	
30	.224	.419	1.94	5.09	13.75	26.01	
40	398	.745	3.45	9.04	24.45	46.23	
50	.621	1.17	5.40	14.13	38.20	73.93	
75	1.40	2.62	12.14	31.79	85.98	162.5	
100	2.48	4 66	21.58	56.52	152.8	289 0	
150	5.59	10.48	48.57	127.2	343.7	650.2	
200	9.04	18.63	86.32	226.1	611.1	1156	
300	22.36	41.92	194.20	508.7	1092.	2601.	

TABLE SHOWING FLOW OF WATER THROUGH RECTANGULAR ORIFICES IN THIN VERTICAL PARTITIONS.

Head upon center of orifice. feet.	Velocity per second. feet.	Breadth and Height of Orifice.									
		1 ft. High. 1 ft. Wide		9 in. High. 1 ft. Wide.		6 in. High. 1 ft. Wide.		3 in. High. 1 ft. Wide.		1.5 in. High 1 ft. Wide.	
		cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
0.2	3.58	.....	.....	.....	.....	.....	.....	.....	.....	.028	.0064
.3	4.40	.....	.....	.....	.....	.....	.....	0.69	.....	.34	.010
.4	5.07	.....	.....	.....	.....	1.56	.....	.071	.....	.40	.018
.5	5.67	.....	.....	.....	.....	2.57	.....	.80	.....	.45	.026
.6	6.22	3.72	.253	2.83	.146	1.74	.099	.89	.051	.49	.033
.7	6.72	4.02	.317	3.06	.193	1.91	.130	.98	.066	.53	.041
.8	7.18	4.31	.392	3.27	.249	2.07	.165	1.06	.082	.57	.052
.9	7.62	4.57	.467	3.48	.356	2.35	.240	1.20	.122	.60	.061
1.0	8.025	4.87	.554	3.67	.417	2.48	.281	1.26	.144	.63	.072
1.25	8.99	5.29	.751	4.02	.571	2.71	.385	1.39	.197	.69	.098
1.50	9.83	5.92	1.01	4.50	.767	3.03	.517	1.55	.259	.77	.129
1.75	10.69	6.40	1.27	4.86	.967	3.27	.650	1.67	.326	.83	.163
2.00	11.35	6.55	1.56	5.20	1.18	3.50	.795	1.79	.398	.89	.199
2.25	12.00	7.27	1.86	5.51	1.41	3.71	.949	1.89	475	.95	.237
2.50	12.68	7.67	2.18	5.81	1.65	3.91	1.11	1.99	.565	1.00	.283
2.75	13.32	8.05	2.53	6.09	1.86	4.10	1.28	2.09	654	1.04	.327
3.00	13.90	8.41	2.8	6.36	2.17	4.27	1.46	2 18	743	1.09	.371
3.50	15.01	9.08	3.61	6.86	2 73	4.61	1.83	2.35	.935	1.17	.467
4.00	16.05	9.97	4.54	7.32	3 33	4.92	2.24	2.50	1.14	1.25	.568
4.50	17.02	10.29	5.26	7.75	3.96	5.21	2.66	2.65	1.36	1.32	.678
5.00	17.95	10.84	6.16	8.16	4.64	5.49	3.12	2.78	1.58	1 39	.781
6.	19.66	11.84	8.08	8.91	6.08	5.98	4.08	3.03	2.07	1.51	1.03
7.	21.23	12.76	10.14	9.61	7.64	6.43	5.12	3.24	2.58	1.62	1.29
8.	22.71	13.64	12.40	10.25	9.32	6.84	6.22	3.45	3 14	1.71	1.52
9.	24.70	14.47	14.80	10.86	11.11	7.25	7.42	3.64	3.72	1.83	1.82
10.	25.38	15.25	17.34	11.44	13.00	7.62	8.66	3.83	4.34	1.92	2.18
15.	31.08	18.68	31.85	14.01	23.88	9.34	15.93	4.69	8.00	2.36	4.02
20.	35.89	21.50	49.05	16.18	36.78	10.8	24.55	5.42	12.29	2.72	6.15
25	40.13	24.12	68.52	18.10	51.42	12.08	34.32	6.06	17.22	3.05	8.67
30.	43.95	26.43	90.10	19.84	67.64	13.47	45.92	6.64	22.64	3.35	11.42
40	47.47	28.55	113.6	21.44	85.27	14.31	56.96	7.18	28.56	3.62	14.40
50	50.75	30.53	138.8	22.94	104.3	15.32	69 64	7.66	34.91	3.79	17.23
75	56.75	32.39	165.6	24.35	124.5	16 26	83.14	8 16	41.73	4.12	21.02
100	62.25	34.15	194.0	25.68	145.8	17.16	97.50	8 61	48.92	4.35	24.72

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TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head.	Velocity per sec.	50 M inch. 1 cu ft.	100 M inch. 2 cu ft.	Diameters of Nozzles. 1 inch		1.5 inches.		2 inches.		2.5 inches.	
Feet.	Feet.	H. P.	H. P.	cu ft.	H. P.	cu. ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
1	8.025	.106	.212	.041	.0046	.093	.010	.164	.018	.255	.029
1.5	9.83	.158	.316	.050	.0085	.111	.019	.200	.034	.312	.053
2	11.35	.211	.422	.058	.013	.130	.029	.232	.052	.360	.082
2.5	12.68	.264	.528	.064	.018	.145	.041	.256	.072	.402	.114
3	13.90	.317	.634	.061	.024	.159	.054	.284	.096	.440	.150
3.5	15 01	.370	.740	.016	.030	.171	.068	.304	.120	.4 5	.189
4	16.05	.421	.842	.081	.03	.183	.083	.324	.148	.507	.231
4.5	17 02	.474	.948	.086	.044	.194	.099	.344	.176	.540	.275
5	17 95	.528	1.06	.091	.051	.205	.113	.364	.204	.56	.315
6	19.66	.634	1.27	.100	.068	.224	.153	.400	.272	.622	.425
7	21.23	.739	1.48	.108	.086	.242	.193	.432	.344	.672	.535
7.5	21.98	.702	1.58	.111	.095	.250	.214	.444	.380	.697	.595
10	25.38	1.06	2.12	.129	.146	.290	.329	.516	.584	.805	.915
12.5	28.37	1.32	2.64	.144	.204	.324	.46	.5 6	.816	.897	1.28
15	31.08	1.59	3.18	.158	.269	.355	.505	.632	1.08	.985	1.68
17.5	33 57	1.85	3.70	.170	.339	.383	.782	.680	1.36	1.06	2.11
20	35 89	2.11	4.22	.182	.414	.410	.931	.728	1.66	1.14	2.58
22.5	38.07	2.38	4.76	.193	.494	.435	1.11	.772	1.98	1.21	3.08
25	40.13	2.64	5.28	.204	578	.458	1.30	.816	2.31	1.27	3.61
27.5	42 08	2.90	5.80	.213	66	480	1.50	.852	2.6	1.33	4.17
30	43.95	3.02	6.04	.228	760	.513	1 71	.912	3.04	1.42	4.75
32.5	45.75	3.34	6.68	.232	857	.522	1.93	.928	3.43	1.45	5.38
35	47.47	3.69	7.38	.241	.958	.542	2.15	.964	3.83	1.51	5.98
40	50.75	4.22	8.44	.257	1.17	.579	2.63	1.03	4.68	1.61	7.31
45	53.83	4.75	9.50	.273	1.40	.614	3.14	1.09	5.60	1.71	8.23
50	56.75	5.28	10.56	.288	1.64	.648	3.68	1.15	6.56	1.79	10.22
60	62.16	6 34	12.68	.385	2.15	.709	4.84	1.26	8.60	1.97	13.43
70	67.14	7.39	14.78	.341	2.71	.766	6.10	1.36	10.84	2.13	16.93
80	71.78	8.46	16.90	.364	3.31	.819	7.45	1.46	13.24	2.27	20.69
90	76.13	9.53	19.06	.386	3.95	.864	8.88	1.54	15.80	2.44	24.68
100	80.25	10.56	21.12	.407	4.63	.916	10.41	1.63	18.52	2.54	28.90
125	89.72	13.21	26.42	.455	6.47	1.02	14.55	1.82	25 88	2.81	40.40
150	98.28	15.85	31.70	.499	8.50	1.12	19.12	2.00	34.00	3.11	53.12
175	106.1	18.50	37.00	.539	10.70	1.21	24.07	2.16	42.80	3.36	66.86
200	113.5	21.14	42.28	.576	13.1	1.29	29.43	2.30	52.4	3.50	81.75
250	127.1	26.42	52.84	.644	18.3	1.45	41.13	2.58	73.2	4.02	114.2
300	139.0	31.70	63.40	.705	24.0	1.59	54.07	2.82	96.0	4.40	150.2
350	150.1	37.08	74.16	.762	30.3	1.71	68.15	3.05	121.2	4.76	189.3
400	160.5	42.27	84.54	.814	37.0	1.83	83.25	3.26	148.0	5.09	231.2
450	170.2	47.64	95.28	.864	44.2	1.94	99.84	3.46	176.8	5.40	276.0
500	179.4	52.84	105.7	.910	51.7	2.05	116.5	3.64	206.8	5.60	323.2
550	188.2	58.22	116.4	.955	59.7	2.10	134.2	3.82	238.8	5.96	372.7
600	196.6	63.41	126.8	.999	68.0	2.23	152.9	3.99	272.0	6.23	475.0
700	212.3	73.98	148.0	1.06	85.7	2.46	192.8	4.36	342.8	6.79	535.5
800	226.9	84.55	169.1	1.15	104.7	2.58	235.5	4.60	418.8	7.19	654.0
900	240.7	95.14	190.3	1.22	124.9	2 75	281.0	4.88	499.6	7.63	780.5
1000	253 8	106.6	211.2	1.20	146.2	2.89	329.0	5.16	584.8	8.04	914.0

TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head.	Velocity per sec.	150 M inch. 3 cu ft	200 M inch. 4 cu ft	Diameters of Nozzles. 3 inches.		3.5 inches.		4 inches.		4.5 inches.	
Feet.	Feet.	H. P.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
1	8.025	.308	.424	.372	.040	.50	.056	.656	.072	.81	.090
1.5	9.83	.474	.632	.444	076	.61	.105	.800	.136	1.00	.171
2	11.35	.633	.844	.520	.116	.70	.160	.928	.208	1.17	.260
2.5	12.68	.792	1.06	.58	.164	.79	.224	1.02	.288	1.80	.370
3	13.90	.951	1.27	.636	.216	.86	.295	1.14	.384	1.43	.485
3.5	15.01	1.110	1.48	.684	.272	.94	.370	1.22	.480	1.54	.612
4	16.05	1.26	1.68	.742	.332	1.02	.452	1.30	.592	1.64	.744
4.5	17.02	1.42	1.90	.776	.396	1.06	.540	1.38	.704	1.74	.905
5	17.95	1.58	2 12	.820	.452	1.11	.600	1.46	.816	1.84	1.02
6	19.66	1.90	2.54	.806	.612	1.22	.833	1.60	1.09	2.01	1.38
7	21.23	2.22	2.96	.968	.772	1.32	1.05	1.73	1.38	2.18	1.74
7.5	21.98	2.38	3.16	1.00	.856	1.36	1.16	1.78	1.52	2.25	1.92
10	25.38	3.18	4.24	1.16	1.32	1.57	1.79	2.16	2.34	2.61	2.97
12.5	28.37	3.96	5.28	1.30	1.84	1.76	2.50	2.30	3.46	2.92	4.14
15	31.08	4.77	6.36	1.42	2.42	1.93	3.29	2.53	4.32	3.19	5.44
17.5	33.57	5.55	7 40	1.53	3.13	2.08	4.20	2.72	5.44	3.44	7.04
20	35.89	6.33	8.44	1.64	3.72	2.23	5.07	2.91	6.64	3.69	8.37
22.5	38.07	7.14	9.52	1.74	4.44	2.36	6.05	3.09	7.92	3.91	9.99
25	40.13	7.92	10.56	1.83	5.20	2.54	7.08	3.26	9.24	4.12	11.70
27.5	42.08	8.70	11.60	1.92	6.09	2 61	8.17	3.41	10.68	4.32	13.50
30	43.95	9.06	12.08	2.05	6 84	2.79	9.31	3.66	12.16	4.61	15.39
32.5	45.75	10.02	13.36	2.09	7.72	2.84	10.50	3.71	13.72	4.70	17.37
35	47.47	11.07	14.76	2.17	8.60	2.95	11.71	3.86	15.32	4.88	19.35
40	50.75	12.66	16.88	2.22	10.52	3.15	14.33	4.12	18.72	5.22	23.67
45	53.83	14.25	19.00	2.46	12.56	3.34	17.10	4.36	22.40	5.54	28.25
50	56.75	15.84	21.12	2.59	14.72	3.52	20.03	4.60	26.24	5.83	32.12
60	62.10	19.02	25.36	2.84	19.36	3.86	26.32	5.04	34.40	6.39	43.55
70	67.14	22.17	29.56	3.06	24.40	4.17	33.17	5.42	43.36	6.84	54.90
80	71.78	25.36	33.86	3.28	20.80	4.40	40.55	5.81	52.96	7.38	67.05
90	76.13	28.59	38.12	3.46	35.52	4.73	48.37	6.16	63.20	7.78	79.92
100	80.25	31.68	42.24	3.66	41.64	4.98	56.67	6.52	74.08	8.23	98.70
125	89.72	39.63	52.84	4.08	58.20	5.57	79.20	7.28	103.5	9.18	130.9
150	98.28	47.55	63.40	4.48	76.48	6.10	104.10	8.00	136.0	10.08	172.1
175	106.1	55.50	74.00	4.84	96.28	6.60	131.07	8.04	171.2	10.89	216.6
200	113.5	63.42	84.56	5.10	117.7	7.05	160.22	9.20	219.6	11.61	261.7
250	127.1	79 26	105.7	5 80	164.5	7.88	223.82	10.32	292.8	13.05	370.2
300	139.0	95.10	126.8	6.36	216.3	8.63	294.3	11.28	384.0	14.31	486 9
350	150.1	111.2	148.3	6.84	272.6	9.33	371.2	12.20	484.8	15.39	613.2
400	160.5	126.8	169.1	7.32	323.0	9.97	458.3	13.04	592.0	16.47	749.2
450	170.2	142.9	190.6	7.76	397.4	10.58	541.0	13.84	707.2	17.46	894.2
500	179.4	158.5	211.4	8.20	486.0	11.15	627.0	14.56	827.2	18.45	1048.
550	188.2	174.7	232.8	8.40	536.8	11.69	731.0	15.28	955.2	18.90	1208.
600	196.6	190.2	253.6	8.92	611.0	12.21	832.7	15.96	1080.0	20.07	1376.
700	212.3	221.0	296.0	9.84	771.2	13.31	1061.	17.44	1371.2	22.14	1735.
800	226.9	253.6	338.2	10 32	942.0	14.10	1282.	18.40	1675.2	23.22	2119.
900	240.7	285.4	380.6	11.00	1124.	14.9	1530.	19.52	1998.4	24.75	2529.
1000	253 8	316.8	422.4	11.66	1316.	15.76	1791.	20.64	2389.2	26.00	2961.

TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head.	Velocity per sec.	300 M inch. 6 cu ft.	400 M inch. 8 cu ft	Diameters of Nozzles. 5 inches.		5.5 inches.		6 inches.		7 inches.	
Feet.	Feet.	H. P.	H. P	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.	cu ft.	H. P.
1	8.025	.616	8.8	1.02	116	1 23	140	1 49	100	1 99	.226
1.5	9.83	.948	1.26	1.25	.212	1.51	.257	1 78	.304	2.44	.420
2	11.35	1.27	1.69	1.44	.327	1.74	.395	2 08	464	2 82	641
2.5	12.68	1.58	2.11	1.61	.457	1.95	.553	2 32	656	3 15	.896
3	13.90	1.90	2.54	1.76	.601	2.13	.727	2.54	864	3.45	1.18
3.5	15.01	2.22	2.96	1.90	.757	2.31	.916	2.74	1.09	3.78	1.48
4	16.05	2.53	3.37	2.03	.925	2.46	1 12	2.97	1.33	4.09	1.81
4.5	17.02	2.84	3.79	2.16	1.10	2.51	1.33	3.10	1.58	4.23	2.16
5	17 95	3.18	4.24	2 27	1.26	2.75	1.53	3 28	1.81	4.40	2.48
6	19.66	3.81	5.08	2.49	1.70	3.02	2.05	3.58	2.45	4.88	3.33
7	21.23	4.44	5.92	2.69	2 14	3.26	2.59	3.87	3.09	5.28	4.20
7.5	21.98	4.74	6.32	2.79	2.38	3.42	2.87	4.00	3.42	5.40	4.66
10	25.38	6.36	8.48	3.22	3.66	3.89	4.42	4.64	5.28	6.30	7.16
12.5	28.37	7.92	10.56	3.59	5.11	4.3	6.18	5.20	7.36	7.05	10.02
15	31 08	9.54	12.72	3.94	6.72	4.76	8.13	5.68	8.08	7.72	13.17
17.5	33.57	11.10	14.80	4.26	8.46	5.15	10.24	6.12	12.52	8.34	16.80
20	35.80	12.66	16.88	4.55	10.34	5.50	12.51	6 56	14.88	8.92	20.28
22.5	38.07	14.28	19.04	4.83	12.34	5.84	14.93	6.96	17.76	9 46	24.20
25	40.13	15.84	21.12	5.09	14.45	6.16	17.49	7.32	20.80	10.15	28.33
27.5	42.08	17.40	23.20	5.34	16.67	6.46	20.18	7.68	24.00	10.40	32.08
30	43.95	18.12	24.16	5.70	19.00	6.90	22.99	8.20	27.36	11.18	37.25
32.5	45.75	20.04	26.72	5.80	21.42	7.02	25.92	8.36	30.88	11.37	41.99
35	47.47	22.14	29.52	6.02	23.94	7.28	28.97	8.68	33.40	11.80	46.84
40	50.75	25 32	33.76	6.44	29.25	7.78	83.39	9.28	42.08	12.61	57.33
45	53.83	29.50	38.00	6.82	34.90	8 26	42.23	9.84	50.24	13.38	68.40
50	56.75	31.68	42.24	7.19	40.87	8.70	49.46	10.36	58.88	14.10	80.11
60	62.16	38.04	50.72	7.88	53.72	9.54	65.01	11.36	77.44	15.44	105.3
70	67.14	44.34	59.12	8.51	67.72	10.30	81.95	12.24	97.60	16.09	132.7
80	71.78	50.74	67.64	9.10	82.76	11.01	100.1	13.12	119.2	17 84	162.2
90	76.13	57.18	76.24	9.65	98.72	11.58	119.5	13.84	142.1	18.92	193.5
100	80.25	63.36	84.48	10.17	115.6	12.31	139.9	14.64	166 6	19.94	226.7
125	89.72	79.26	95.68	11.38	161.6	13.76	195.0	16.32	232 8	22.30	316.8
150	98.28	95.10	126.8	12.46	212.5	15.08	257.0	17.92	305.9	24.42	416.4
175	106.1	111.0	148.0	13.46	267.5	15.29	313.7	19.36	385.1	26 39	524.3
200	113.5	126.8	169.1	14.34	327.0	17.51	395.7	20.64	470.8	28 20	640.9
250	127 1	158.5	211.4	16.09	457.0	19.47	553.0	3.20	658.0	31.54	895.7
300	139.0	190.2	253.6	17.62	601.0	21.33	726.9	25.44	865.2	34.54	1177.
350	150.1	222.5	296.6	19.04	757.2	22.04	916.3	27.36	1090.4	37.32	1485.
400	160.5	253.6	338.2	20.35	925.0	24.62	1179.	29.28	1332.	29.89	1813.
450	170.2	285.8	381.1	21.59	1104.	26.12	1335.	31.04	1590.	42.31	2164.
500	179.4	317.1	422.8	22.75	1293.	27.54	1566.	32.80	1864.	44.00	2508.
550	188.2	349.2	465.6	23.86	1491.	28.88	1805	33 60	2147	46.78	2922.
600	196.6	380.4	507.2	24.93	1699.	30.16	2056.	35.08	2446.	48.86	3331.
700	212.3	444.0	592.0	27.18	2142.	32.88	2591.	39.36	3085.	53.26	4203.
800	226.9	507.2	6 6.4	28.77	2616.	34.92	3166.	41.28	3768.	56.40	5129.
900	240.7	570.9	761.2	30.52	3122.	36.94	3778.	44.00	4496.	59.83	6120.
1000	253 8	638.6	844.8	32.17	3656.	38.93	4424.	46.24	5264.	63.06	7166.

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TABLE SHOWING FLOW OF WATER THROUGH NOZZLES—QUANTITY AND HORSE-POWER.

Head. Feet.	Velocity pr sec Feet.	500 Min. inch. 10 c ft H. P.	1000 Min. inch. 20 c ft H. P.	Diameters of Nozzles. 8 inches. cu ft.	H. P.	9 inches. cu ft.	H. P.	10 inches. cu ft.	H. P.	12 inches. cu ft.	H. P.
1	8.025	1.06	2.12	2.62	.288	3.35	.360	4.07	.46	5.96	.904
1.5	9.83	1.58	3.16	3.20	.544	3.99	.684	4.99	.85	7.12	1.68
2	11.35	2.11	4.22	3.71	.832	4.68	1.04	5.76	1.3	8.32	2.56
2.5	12.68	2.64	5.28	4.08	1.15	5.22	1.48	6.44	1.83	9.28	3.58
3	13.90	3.17	6.34	4.56	1.54	5.72	1.94	7.05	2.40	10.16	4.72
3.5	15.01	3.70	7.40	4.88	1.92	6.16	2.45	7.62	3.03	10.90	5.92
4	16.05	4.21	8.42	5.20	2.37	6.58	2.99	8.14	3.70	11.88	7.24
4.5	17.02	4.74	9.48	5.52	2.81	6.98	3.26	8.64	4.42	12.40	8.64
5	17.95	5.28	10.6	5.84	3.26	7.38	4.07	9.10	5.05	13.12	9.92
6	19.66	6.34	12.7	6.40	4.36	8.06	5.51	9.97	6.80	14.32	13.32
7	21.23	7.39	14.8	6.92	5.52	8.71	6.95	10.77	8.57	15.48	16.80
7.5	21.98	7.92	15.8	7.12	6.08	9.00	7.70	11.14	9.50	16.00	18.64
10	25.38	10.6	21.2	8.64	9.36	10.41	11.88	12.87	14.69	18.56	28.64
12.5	28.37	13.2	26.4	9.20	13.84	11.70	16.56	14.39	20.44	20.80	40.08
15	31 08	15.9	31.8	10.12	17.28	12.78	21.78	15.76	26.87	22.72	52.68
17.5	33.57	18.5	37.0	10.88	21.76	13.77	28.17	17.03	33.86	24.48	67.20
20	35.89	21.1	42.2	11.64	26.56	14.76	33.48	18.20	41.32	26.24	81.12
22.5	38.07	23.8	47.6	12.36	31.68	15.66	39.96	19.31	49.37	27.84	96.80
25	40.13	26.4	52.8	13.04	36.96	16.47	46.80	20.35	57.82	29.28	113.3
27.5	42.08	29.0	58.0	13.64	42.72	17.28	54.00	21.34	66.76	30.72	130.7
30	43.95	30.2	60.4	14.60	48.64	18.45	61.56	22.81	76.01	32.80	149.0
32.5	45.75	33.4	66.8	14.84	54.88	18.81	69.48	23.20	85.70	33.44	168.9
35	47.47	36.9	73.8	15.44	61.28	19.53	77.40	24.08	95.78	34.72	187.4
40	50.75	42.2	84.4	16.48	74.88	20.88	94.68	25.74	117.0	37.12	229.3
45	53.83	47.5	95.0	17.44	89.60	22.14	113.0	27.30	139 6	39.36	273.6
50	56.75	52.8	105.6	18.40	105.0	23.31	128.5	28.78	163.5	41.44	320.4
60	62.16	63.4	126.8	20.16	137.6	25.56	174.2	31.53	214.9	45.44	421.2
70	67.14	73.9	147.8	21.68	173.4	27.54	219.6	34.06	270.9	48.96	530.8
80	71.78	84.6	169.0	23.36	211.8	29.52	268.2	36.41	331.0	52.48	648.8
90	76.13	95.3	190.6	24.64	252.8	31.14	319.7	38.61	394.9	55.86	774.0
100	80.25	105.6	211.2	26.08	296.3	32.94	374.8	40.70	462.5	58.56	906.8
125	89.72	132.1	264.2	29.12	414.0	36.72	523.8	45.51	646.5	65.28	1267.
150	98.28	158.5	317.0	32.00	554.0	40.32	688.3	49.85	849.8	71.68	1666.
175	106.1	185.0	370.0	34.56	684.8	43.56	866.5	53.85	1070.	77.44	2097.
200	113.5	211.4	422.8	36.80	878.4	46.44	1059.	57.56	1308.	82.56	2564.
250	127.1	264.2	528.4	41.28	1171.	52.20	1481.	64.36	1828.	92.80	3583.
300	139.0	317.0	634.0	45.12	1536.	57.24	1947.	70.50	2403.	101.76	4708.
350	150.1	370.8	741.6	48.80	1949.	61.56	2453.	76.15	3029.	109.4	5940.
400	160.5	422.7	845.4	52.16	2368.	65.88	2997.	81.41	3700.	117.1	7252.
450	170.2	476.4	952.8	55.36	2829.	69.84	3577.	86.35	4415.	124.2	8656
500	179.4	528.4	1057.	58.24	3409.	73.80	4194.	91.02	5172.	131.2	10032
550	188.2	582.2	1164.	61.12	3821.	75.60	4831.	95.46	5966.	134.4	11692.
600	196.6	634.1	1268.	63.84	4352.	80.28	5504.	99.71	6798.	142.7	13324.
700	212.3	739.8	1480.	69.76	5485.	88.56	6191.	108.7	8567.	157.4	16812.
800	226.9	845.5	1691.	73.60	6701.	92.88	8478	115.1	10468.	165.1	20516
900	240.7	951.4	1903.	78.08	7994.	99.00	10116.	122.5	12489.	176.0	24480
1000	253.8	1056.	2112.	82.56	9357.	104.0	11844.	128.7	14624.	185.0	28664

RISDON IRON WORKS

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TABLE SHOWING LOSS OF HEAD

— FOR —

EACH 100 FEET IN LENGTH OF DIFFERENT DIAMETERS OF PIPE

When Discharging the following quantities of Water per minute.

INSIDE DIAMETER OF PIPE IN INCHES.

1			2		3		4		5		6	
Velo. in ft. per sec.	Loss of head in feet	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
2.0	1.98	.65	988	2.62	.659	5.89	.494	10.4	.395	16.3	.329	23.5
2.2	2.34	.73	1.170	2.88	.780	6.48	.585	11.5	.468	18.	.390	25.9
2.4	2.73	.79	1.366	3.14	.911	7.07	.683	12.5	.547	19.6	.456	28.2
2.6	3.15	.86	1.576	3.40	1.05	7.65	.788	13.6	.631	21.3	.526	30.6
2 8	3 60	.92	1.800	3.66	1.20	8.24	.900	14.6	.720	22.9	.600	32.9
3.0	4.08	.99	2.04	3.92	1.35	8.83	1.02	15.7	.815	24.5	.679	35 3
3.2	4.56	1.06	2.28	4.18	1.52	9.42	1.14	16.7	.915	26.2	763	37.7
3.4	5.08	1.12	2.54	4.45	1 70	10.00	1.27	17.8	1.02	27 8	.851	40.
3.6	5.64	1.19	2.82	4.71	1.89	10.60	1.41	18.8	1.13	29.4	.943	42.4
3.8	6.24	1.26	3.12	4.97	2 08	11.20	1.56	19.9	1.25	31.	1.04	44.7
4.0	6.84	1.32	3.42	5.23	2.28	11.80	1.71	20.9	1.37	32.7	1.14	47.1
4.2	7.48	1.39	3.74	5.49	2.49	12.30	1.87	22.0	1.50	34.3	1.25	49.5
4.4	8 12	1.45	4.06	5.76	2.71	12.90	2.03	23.0	1.63	36.0	1.35	51.8
4.6	8.84	1.52	4.42	6.02	2.94	13.50	2.21	24.0	1 76	37.5	1.47	54.1
4.8	9.52	1.58	4.76	6.28	3.18	14.10	2.38	25.1	1.91	39.2	1.59	56.5
5.0	10.28	1.65	5.14	6.54	3.43	14.70	2.57	26.2	2.05	40.9	1.71	58.9
5.2	11.04	1.72	5.52	6.80	3.68	15.30	2.76	27.2	2.21	42.5	1.84	61.2
5.4	11.84	1.78	5.92	7.06	3.94	15.90	2.96	28.2	2.37	44.2	1.97	63.6
5.6	12.64	1.85	6.32	7.32	4.22	16.50	3.16	29.3	2.53	45.8	2.11	65.9
5.8	13.48	1.91	6.74	7.58	4.50	17.10	3.37	30.3	2.70	47.4	2.25	68.3
6.0	14.36	1.98	7.18	7.85	4.78	17.70	3.59	31.4	2.87	49.1	2.39	70.7
7.0	19.08	2.31	9.54	9.16	6.35	20.6	4.77	36.6	3.81	57.2	3.18	82.4

INSIDE DIAMETER OF PIPE IN INCHES.

7			8		9		10		11		12	
Velo. in ft. per sec.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
2.0	.282	32.0	.247	41.9	.220	53.	.198	65.4	.180	79.2	.165	94.2
2.2	.334	35.3	.293	46.1	.260	58.3	.234	72.	.213	87.1	.195	103.
2.4	.390	38.5	.342	50.2	.304	63.6	.273	78.5	.248	95.0	.228	113.
2.6	.450	41.7	.394	54.4	.350	68.9	.315	85.1	.287	103.	.263	122.
2.8	.514	44.9	.450	58.6	.400	74.2	.360	91.6	.327	111.	.300	132.
3.0	.582	48.1	.509	62.8	.453	79.5	.407	98.2	.370	119.	.339	141.
3.2	.654	51.3	.572	67.	.508	84.8	.458	105.	.416	127.	.381	151.
3.4	.729	54.5	.638	71.2	.567	90.1	.510	111.	.464	134.	.425	160.
3.6	808	57.7	.707	75.4	.629	95 4	.566	118.	.514	142.	.472	169.
3.8	.892	60.9	.780	79.6	.693	101.	.624	124.	567	150.	.520	179.
4.0	.979	64.1	.856	83.7	.761	106.	.685	131.	.623	158.	.571	188.
4.2	1.07	67.3	.935	87.9	.832	111.	.748	137.	.680	166.	.624	198.
4.4	1.16	70.5	1.02	92.1	.905	116.	.814	144.	.740	174.	.679	207.
4.6	1.26	73.7	1.10	96.3	.981	122.	.883	150.	.803	182.	.736	217.
4.8	1.36	76.9	1.19	100.0	1.06	127.	.954	157.	.867	190.	.795	226.
5.0	1.47	80.2	1.28	105.	1.14	132.	1.03	163.	.935	198.	.857	235.
5.2	1.58	83 3	1.38	109.	1.23	138.	1.10	170.	1.00	206.	.920	245.
5.4	1.69	86.6	1.48	113.	1.31	143.	1.18	177.	1.07	214.	.986	254.
5.6	1.81	89.8	1.58	117.	1.40	148.	1.26	183.	1.15	222.	1.05	264.
5.8	1.93	93.0	1.68	121	1.50	154.	1.35	190.	1.22	229.	1.12	273.
6.0	2.05	96.2	1.79	125.	1.59	159.	1.43	196.	1.30	237.	1.19	283.
7.0	2.72	112 0	2.38	146.	2.12	185.	1.90	229.	1.73	277.	1.59	330.

Add 20 per cent. to "loss of Head" given above in calculations for Riveted Pipe.

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TABLE SHOWING LOSS OF HEAD

— FOR —

EACH 100 FEET IN LENGTH OF DIFFERENT DIAMETERS OF PIPE

When Discharging the following quantities of Water per minute.

INSIDE DIAMETER OF PIPE IN INCHES.

13			14		15		16		18		20	
Velo. in ft. per. sec.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min
2.0	.152	110.	.141	128.	.132	147.	.123	167	.110	212.	099	262.
2.2	.180	121.	.167	141.	.156	162.	.146	184.	.130	233.	117	288.
2.4	.210	133.	.195	154.	.182	176.	.171	201.	.152	254.	137	314.
2.6	.242	144.	.225	167.	210	191.	197	218.	.175	275.	158	340.
2.8	.277	156.	.257	179.	.240	206.	.225	234.	.200	297.	180	366.
3.0	.313	166	.291	192.	.271	221.	.255	251.	.226	318.	.204	393.
3.2	.352	177.	.327	205.	.305	235.	.286	268.	.254	339.	.229	419.
3.4	.393	188.	.365	218.	.340	250.	.319	284.	.283	360.	255	445.
3.6	.435	199.	.404	231.	.377	265.	.354	301.	.314	382.	283	471.
3.8	.480	210.	.446	243.	.416	280.	.390	318.	.347	403.	.312	497
4.0	.527	221.	.489	256.	.457	294.	.428	335.	.380	424.	.342	523
4.2	.576	232.	.534	269.	.499	309.	.468	352.	.416	445	.374	550
4.4	.626	243.	.582	282.	.543	324.	.509	368.	.452	466.	.407	576
4.6	.679	254.	.631	295.	.589	339.	.552	385.	.490	488.	.441	602.
4.8	.734	265.	.682	308.	.636	353.	.596	402.	.530	509	477	628.
5.0	.791	276.	.734	321.	.685	368.	.642	419.	.571	530	.514	654.
5.2	.850	287.	.789	333.	.736	383.	.690	435.	.614	551.	.552	680.
5.4	.910	298.	.845	346.	.789	397.	.740	452.	.657	572.	.592	707.
5.6	.973	309.	.903	359.	.843	412.	.791	469.	.703	594.	.632	733.
5.8	1.04	321.	.964	372.	.899	427.	.843	486.	.749	615.	674	759.
6.0	1.10	332.	1.02	385.	.957	442.	.897	502.	.798	636.	718	785.
7.0	1.46	387.	1.36	449.	1.27	515.	1.19	586.	1.06	742.	.953	916.

INSIDE DIAMETER OF PIPE IN INCHES.

22			24		26		28		30		36	
Velo. in ft. per sec.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.	Loss of head in feet.	Cubic feet per min.
2.0	090	316	082	377.	.076	442.	.070	513	066	589.	.055	848.
2 2	.106	348.	097	414.	090	486.	.083	564.	.078	648.	.065	933.
2.4	.124	380	114	452	.105	531.	.097	616.	.091	707.	.076	1018.
2.6	.143	412	131	490.	.121	575.	.112	667.	105	766.	.087	1100.
2.8	.164	443.	150	528.	.138	619.	.128	718.	.120	824.	.100	1188.
3.0	.185	475.	.170	565.	.157	663.	.145	770.	.136	883.	.113	1273
3.2	.208	507.	.191	603.	.176	708.	.163	821	152	942.	.127	1357.
3.4	.232	538.	.213	641.	.196	752.	.182	872.	170	1001.	.141	1442.
3.6	.257	570.	.236	678	.218	796.	.202	923.	189	1060.	.157	1527.
3.8	.284	601	.260	716.	.240	840.	.223	974.	208	1119.	.173	1612.
4.0	.311	633	.285	754.	.263	885.	.244	1026.	.228	1178.	.190	1697.
4.2	.340	665	.312	791	288	929.	.267	1077.	249	1237.	.208	1782.
4.4	.370	697	.339	829.	.313	973.	.290	1129.	271	1296.	.226	1866.
4.6	.401	728	368	867.	.339	1017.	.315	1180	.294	1355.	.245	1951.
4.8	.434	760	.397	905.	.367	1062.	.341	1231.	.318	1414.	.265	2036.
5 0	467	792	428	942.	.395	1106	.367	1283.	.343	1472.	.285	2121.
5.2	.502	823	460	980.	.425	1150.	.394	1334	368	1531.	.307	2206.
5.4	.538	855	.493	1018.	.455	1194	.423	1385	394	1590.	.328	2291.
5 6	.575	887.	.527	1055	.486	1239	452	1437	422	1649	.351	2376.
5 8	613	918	562	1093	.519	1283	482	1488	450	1708	375	2460.
6 0	.652	950	598	1131	.552	1327	513	1539	478	1767	.399	2545.
7.0	.867	1109.	794	1319.	.733	1548	.681	1796	.635	2061	.530	2868.

Add 20 per cent. to "loss of Head" given above in calculations for Riveted Pipe.

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TABLES

FOR

CALCULATING THE HORSE-POWER OF WATER

MINERS' INCH TABLE

The following table gives the Horse-Power of one miner's inch of water under heads from one up to eleven hundred feet. This inch equals 1½ cubic feet per minute.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0024147	320	.772704
20	.0482294	330	.796851
30	.072441	340	.820998
40	.096588	350	.845145
50	.120735	360	.869292
60	.144882	370	.893439
70	.169029	380	.917586
80	.193176	390	.941733
90	.217323	400	.965880
100	.241470	410	.990027
110	.265617	420	1.014174
120	.289764	430	1.038321
130	.313911	440	1.062468
140	.338058	450	1.086615
150	.362205	460	1.110762
160	.386352	470	1.134909
170	.410499	480	1.159056
180	.434646	490	1.183206
190	.458793	500	1.207350
200	.482940	520	1.255644
210	.507087	540	1.303938
220	.531234	560	1.352232
230	.555381	580	1.400526
240	.579528	600	1.448820
250	.603675	650	1.569555
260	.627822	700	1.690290
270	.651969	750	1.811025
280	.676116	800	1.931760
290	.700263	900	2.173230
300	.724410	1000	2.414700
310	.748557	1100	2.656170

CUBIC FEET TABLE

The following table gives the Horse-Power of one cubic foot of water per minute under heads from one up to eleven hundred feet.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0016098	320	.515136
20	.032196	330	.531234
30	.048294	340	.547332
40	.064392	350	.563430
50	.080490	360	.579528
60	.096588	370	.595626
70	.112686	380	.611724
80	.128784	390	.627822
90	.144892	400	.643920
100	.160980	410	.660018
110	.177078	420	.676116
120	.193176	430	.692214
130	.209274	440	.708312
140	.225372	450	.724410
150	.241470	460	.740508
160	.257568	470	.756606
170	.273666	480	.772704
180	.289764	490	.788802
190	.305862	500	.804900
200	.321960	520	.837096
210	.338058	540	.869292
220	.354156	560	.901488
230	.370254	580	.933684
240	.386352	600	.965880
250	.402450	650	1.046370
260	.418548	700	1.126860
270	.434646	750	1.207350
280	.450744	800	1.287840
290	.466842	900	1.448820
300	.482940	1000	1.609800
310	.499038	1100	1.770780

When the Exact Head is Found in Above Table

EXAMPLE.—Have 160 foot head and 50 inches of water. How many Horse-Power?

By reference to above table the Horse-Power of 1 inch under 100 feet head is .241470. This amount multiplied by the number of inches, 50, will give 12.07 Horse-Power.

When Exact Head is Not Found in Table

Take the Horse-Power of 1 inch under 1 foot head and multiply by the number of inches, and then by number of feet head. The product will be the required Horse-Power.

NOTE.—The above formula will answer for the cubic feet table, by substituting the equivalents therein for those of miner's inches.

HORSE POWER GIVEN IN ABOVE TABLE=85 PER CENT. OF THEORETICAL POWER.

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GOLD TABLE

FOR DETERMINING THE

Value of Free Gold per Ton (2000 lbs.) of Quartz or Cubic Yard of Gravel,

PREPARED BY

MELVILLE ATWOOD, Esq., F. G. S., Consulting Mining Engineer.

WEIGHT WASHED GOLD. 4-LB. SAMPLE. GRAINS.	FINENESS, 780. VALUE PER OZ. $16 12	FINENESS, 830. VALUE PER OZ. $17 15	FINENESS, 875. VALUE PER OZ. $18 08	FINENESS, 920. VALUE PER OZ. $19.01
5 grains	$83 97	$89 36	$94 20	$99 05
4 "	67 18	71 49	75 36	79 24
3 "	50 38	53 61	56 52	59 43
2 "	33 59	35 74	37 68	39 62
1 "	16 79	17 87	18 84	19 81
.9 "	15 11	16 08	16 95	17 82
.8 "	13 43	14 29	15 07	15 84
.7 "	11 75	12 51	13 19	13 86
.6 "	10 07	10 73	11 30	11 88
.5 "	8 40	8 93	9 42	9 90
.4 "	6 71	7 14	7 53	7 92
.3 "	5 03	5 36	5 65	5 94
.2 "	3 36	3 57	3 76	3 96
.1 "	1 68	1 78	1 88	1 98

Explanation of Table.

The foregoing table furnishes an exceedingly simple method of determining the value of *free gold* in a ton of gold-bearing quartz, or a cubic yard of auriferous gravel.

Take a sample of four (4) pounds of quartz, pulverize it to the usual fineness for horning; wash it carefully by batea or other means; amalgamate the gold by the application of quicksilver; volatalize the quicksilver by blow-pipe or otherwise; weight the resulting button, and the value given in the table opposite such weight will be the value in free gold per ton of 2000 lbs. of quartz.

EXAMPLE.

Sample of four pounds produces button weighing one grain, the finest of the gold being 830; then the value of one ton of such quartz will be $17 87.

If the sample of four pounds should produce a button weighing say two and four-tenths (2 4-10) grains, then the value of such quartz would be (875 fine) as follows, viz:

Opposite 2 grains	875 fine	value $37 68
" 4-10 "	875 "	" 7 53
Total value per ton (2000 lbs.)		$45 21

Gold Value of a Cubic Yard of Gravel.

To determine the gold value of a cubic yard of auriferous gravel, the foregoing table can be used.

Take a sample of sixty (60) pounds of gravel, pulverize it, and carefully wash it by batea, pan or otherwise; amalgamate the gold, volatalize the quicksilver; weigh the button, and in column in foregoing table, opposite the weight, will be found the gold value of a cubic yard of the gravel.

EXAMPLE.

Sample of sixty pounds produces button weighing one grain, the fineness of the gold being 780; then the value of one cubic yard of such gravel would be $1.67. This is arrived at by pointing off one point, or dividing the value given in table by 10.

If the sample of sixty pounds yields a button weighing one grain and two-tenths (1 2-10 grains,) then the value of the gravel per cubic yard would be—gold being 920 fine—as follows:

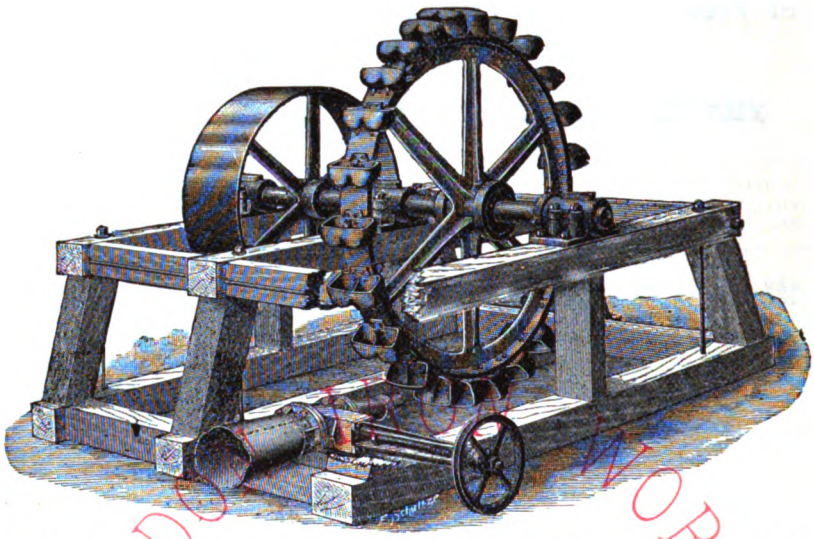
Opposite 1 grain	920 fine	value $1 98
" 2-10 "	920 "	" 03+
Total value cubic yard		$2 01+

This table is prepared upon the following basis of weights, viz: A sample of four pounds of quartz is the one-five-hundredth part in weight of a ton of 2000 pounds, and the gold values given are reduced to this proportion.

Eighteen cubic feet of gravel in bank will weigh one ton, or 2000 lbs., and a cubic yard, or twenty-seven cubic feet, will weigh 3000 lbs., or 1½ tons; and sixty pounds being the one-fiftieth part of the weight of a cubic yard, then the relative proportion of the weight of quartz to gravel is as 50 to 500, or 1 to 10.

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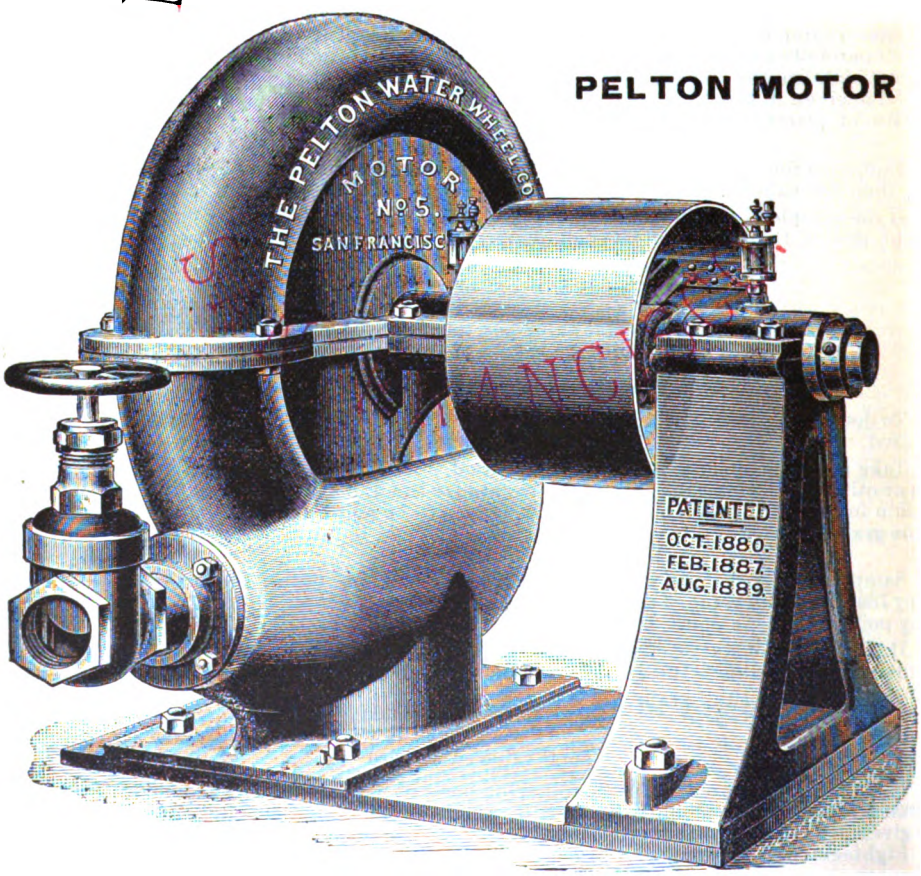
THE PELTON WATER WHEEL



Affords the most simple and reliable power for mining and manufacturing machinery. Adapted to heads ranging from 20 to 2,000 feet.

Gives 85 per cent of the theoretical power of water.

PELTON MOTOR



RISDON IRON WORKS

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PRICE LIST, POWER AND WEIGHT OF PELTON WATER WHEELS (Standard Sizes)

Head in Feet	3-Foot Wheel		4-Foot Wheel		5-Foot Wheel		6-Foot Wheel	
	H. P.	Price	H. P.	Price	H. P.	Price	H. P.	Price
20	1.50	$220	2.64	$285	4.18	$350	6.00	$400
50	5.98	220	10.60	285	16.63	350	23.93	400
80	12.04	230	21.44	295	33.54	370	48.16	425
100	16.84	240	29.93	300	46.85	380	67.36	450
150	31.01	250	55.08	320	86.22	400	124.04	475
200	47.75	265	84.81	350	132.70	425	191.00	500
250	66.74	280	118.54	375	185.47	450	266.96	550
300	87.73	300	155.83	400	243.82	485	350.94	625
350	110.56	320	196.38	425	307.25	550	442.27	700
400	135.08	340	239.94	460	375.40	625	540.35	800
450	161.19	360	286.31	500	447.95	700	644.78	900
500	188.80	390	335.34	540	524.66	775	755.20	1000
550	223.76	425	397.43	600	621.82	.....	895.04	.....
600	248.16	450	440.77	675	689.63	.....	992.65	.....
700	312.73	500	555.46	750	869.06	.....	1250.92	.....
800	382.09	.....	678.66	.....	1061.81	.....	1528.36	.....
900	455.94	.....	809.82	.....	1267.02	.....	1823.76	.....
1000	534.01	.....	948.48	.....	1483.97	.....	2136.04	.....
	Weight, 700 to 1000 lbs.		Weight, 1000 to 1700 lbs.		Weight, 1400 to 2100 lbs.		Weight, 2100 to 3000 lbs.	

PRICE LIST AND POWER OF TWO NOZZLE WHEELS

Head in Feet	3-Foot Wheel		4-Foot Wheel		6-Foot Wheel	
	H. P.	Price	H. P.	Price	H. P.	Price
20	3.00	$300	5.28	$375	12.00	$500
30	5.52	300	9.76	375	22.08	500
40	8.48	310	15.16	380	33.92	510
50	11.96	325	21.28	385	47.86	520
60	15.68	340	27.88	390	62.72	530
70	19.76	360	35.16	400	79.04	550
80	24.08	380	42.88	420	96.32	575
100	33.68	400	59.86	450	134.72	600
150	62.02	440	110.16	500	248.08	700
200	95.50	480	169.62	575	382.00	800
250	133.48	525	237.08	650	533.92	900
	Weight, 950 to 1250 lbs.		Weight, 1250 to 2000 lbs.		Weight, 2400 to 4000 lbs.	

PRICE LIST OF PELTON WATER MOTORS

Head in Feet	No. 1 6-Inch Wheel		No. 2 12-Inch Wheel		No. 3 18-Inch Wheel		No. 4 18-Inch Wheel		No. 5 24-Inch Wheel	
	H. P.	Price	H. P.	Price	H. P.	Price	H. P.	Price	H. P.	Price
20	.05	$30	.12	$60	.20	$125	.37	$175	.66	$275
50	.21	30	.49	60	.84	125	1.49	175	2.65	275
80	.43	30	1.00	60	1.70	125	3.10	175	5.36	275
100	.60	30	1.40	60	2.32	125	4.21	175	7.49	275
150	1.10	30	2.58	60	4.37	125	7.75	175	13.77	275
200	1.70	30	3.97	60	6.74	125	11.93	175	21.20	275
250	2.38	30	5.56	60	9.42	125	16.68	175	29.63	275
300	3.13	35	7.31	70	12.38	140	21.93	200	38.95	300
350	3.94	35	9.21	70	15.61	140	27.64	200	49.09	300
400	4.82	40	11.25	80	19.07	150	33.77	220	59.98	320
450	5.75	40	13.43	80	22.76	150	40.29	220	71.57	320
500	6.74	50	15.73	90	26.66	160	47.20	230	83.83	330
	Weight, 25 lbs.		Weight, 75 lbs.		Weight, 260 lbs.		Weight, 280 lbs.		Weight, 600 lbs.	

RISDON IRON WORKS SAN FRANCISCO

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

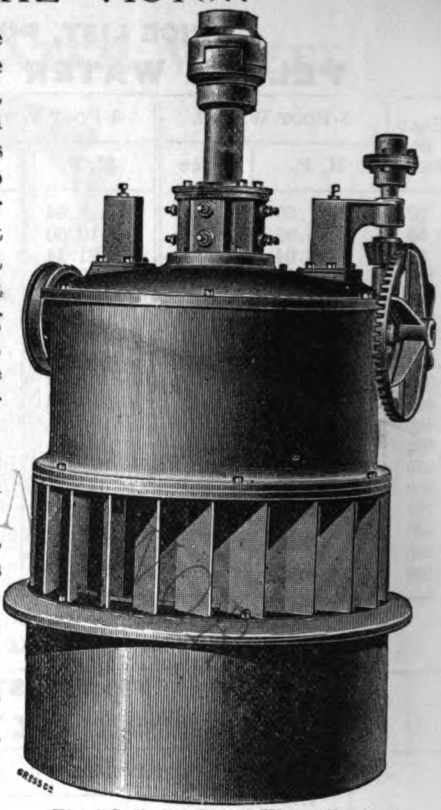
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POWER OF THE VICTOR

We invite particular attention to the EXTRAORDINARY POWER developed by the Victor Wheel in proportion to its diameter, being from two to three times greater than that of other turbines hitherto regarded as first class wheels—a fact so startling as to be almost incredible at first to many of our correspondents. This feature is of great practical importance in the application of a wheel to the propulsion of machinery, as it carries with it numerous advantages among which we may name economy of space, quick speed (a matter of special importance under *low falls*) light gearing, less wear and tear, and loss in transmitting power. It also secures greater accuracy of construction, with better finish and proportional strength of each part.

This feature of great capacity in a small diameter of wheel particularly adapts the Victor for shipment over long and expensive routes, as its weight per horse power is much less than wheels of ordinary construction.

We claim that in the construction of the Victor we have reduced the various parts of a portable wheel and case to the smallest possible number compatible with the greatest efficiency.



The "Cylinder Gate" Victor Turbine.

Every separate piece of our wheel and case is fitted up to a standard gauge with the greatest care—the labor being performed with the most improved machinery.

We invite the most careful comparison of our Victor Wheel in all respects with any and all other turbines in the market; and without wishing to boast, we challenge competition from any source, in respect to POWER, SIMPLICITY, DURABILITY, STRENGTH AND ACCESSIBILITY OF ALL ITS PARTS.

Results of Tests of the

"Cylinder Gate" Victor Turbine,

MADE IN THE TESTING FLUME OF THE HOLYOKE WATER POWER CO., HOLYOKE, MASS.

Size of Wheel.	Head in Feet.	Revolutions of Wheel per Minute.	Cubic Feet Water per Min.	Horse Power Developed by Wheel.	Percentage Useful Effect.
30-inch Full Gate	17.51	168	4440	119.56	81.35
⅞ "	17.82	163	3892	104.93	80.03
¾ "	17.95	163	3392	88.24	76.66
⅝ "	18.10	155	2893	70.97	71.28
½ "	18.20	159	2265	51.42	63.46
36-inch Full Gate	16.78	135	6106	158.18	81.80
⅞ "	17.14	135	5422	141.58	80.71
¾ "	17.35	140	4708	118.22	76.68
⅝ "	17.05	129	3982	91.62	71.50
½ "	17.48	134	3202	66.87	63.30
39-inch Full Gate	14.66	116	6873	152.66	80.37
⅞ "	14.53	118	5920	129.41	79.80
¾ "	16.84	125	5517	135.56	77.40
⅝ "	17.06	123	4695	108.22	71.67
½ "	17.39	124	3856	81.00	64.07
48-inch Full Gate	13.23	91	10072	201.71	80.11
⅞ "	14.36	89	9042	192.41	78.42
¾ "	14.75	89	7869	165.23	75.34
⅝ "	14.87	85	6744	132.76	70.06
½ "	15.28	87	5526	100.66	63.09

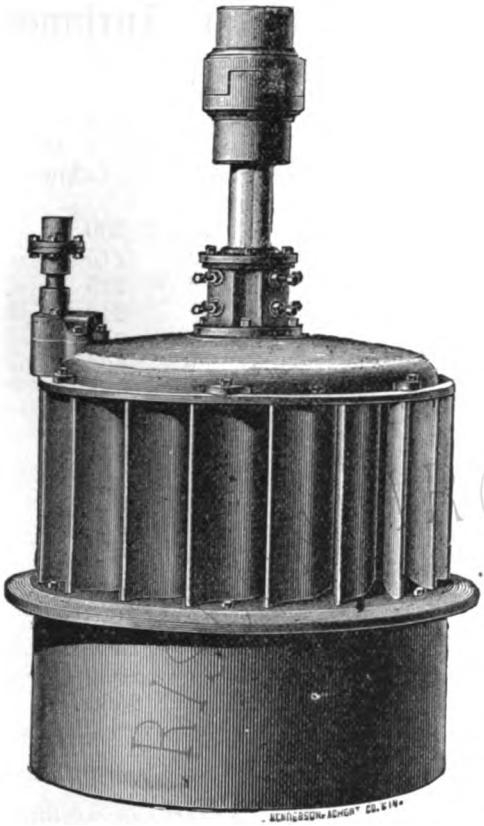
NOTE.—In the above calculations "fractional gate" means "fractional water," regardless of the position of the gate of the turbine; that is, "three-quarters gate" means that the gate is closed to a point where the discharge of water is only three-fourths of what it is at full gate *under the same head.*

RISDON AGENT OF PACIFIC COAST.

Circulars and Full Information on Application.

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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THE "REGISTER GATE" VICTOR TURBINE.
(Patented Oct. 2, 1877.)

The

Victor Turbine

Is the

Best in the World!

Possesses more than double the capacity of other water wheels of same diameter and has produced the best series of results on record in Holyoke Testing Flume, as will appear in the tests reported in our circular, which is furnished on application.

In construction it is compact, simple and strong and is provided with a perfect gate that operates easily under any head.

SCIENTIFIC TESTS.

EXAMINE THE RECORD MADE BY THE

"Register Gate" Victor Turbine

In the Testing Flume at Holyoke, Mass., and reported below.

Various sizes of the "REGISTER GATE VICTOR TURBINE" have been subjected to a series of tests in the Holyoke Testing Flume, by competent and disinterested engineers, for the purpose of correctly determining its power and efficiency, and the results developed as published herewith, are the BEST ON RECORD. This testing flume is provided with all the most improved appliances for making such tests, and is open to all on the same terms. All of the wheels of any considerable reputation have been tested, and the results produced are on record, so that parties desiring to investigate the actual efficiency of the respective Turbines can do so:

	Head in feet.	Revolutions per minute.	Horse Power.	Cubic Feet of Water per Min.	Percentage Useful Effect.
15-inch wheel	18 06	368	30 17	990 19	.8932
	18 08	355	30 12	996 83	.8849
17½-inch wheel	18 02	280	35 51	1164 60	.8960
	17 96	292	36 35	1197	.8950
	17 96	284 6	35 84	1202 4	.8790
20-inch wheel	18 22	286	48 75	1660 17	.8532
	18 23	275	48 75	1660 17	.852[illegible]
	18 21	269 5	49	1671 57	.8522
25-inch wheel	17 79	205 5	67 72	2362 72	.8530
	17 96	209	68 62	2356 54	.8584
	17 80	212 5	67 61	2356	.8533
30-inch wheel	11 65	144 5	52 64	2751 87	.8676
	11 66	147 5	51 96	2755 09	.8564
	11 70	142	52 02	2738	.8614
35-inch wheel	17 31	151 7	135 68	4895	.8489
	17 29	160	133 19	4806	.8497
	17 32	147	136 08	4805	.8491
40-inch wheel	16 49	130	148 93	5789	.8253
	16 47	124	148 88	5816	.8221
44-inch wheel	15 54	116 50	155 47	6585	.8037
	15 50	109 25	155 78	6643	.8003
48-inch wheel	15 51	102	179 29	7456	.8202

Circulars and Full Information on Application.

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Price List of "Register Gate" Victor Turbines

Of Standard Pattern and Weight, page 39.

In selecting a Turbine, price should not be considered alone, but HIGH EFFICIENCY, SUPERIORITY OF CONSTRUCTION, SIMPLICITY and a PERFECT GATE should be estimated at a fair value. From and after this date the following prices will be in force, but are subject to change without notice:

6-inch	wheel	made	of	Brass		Price	$ 200
8	"	"	"	"		"	215
10	"	"	"	"		"	225
12	"	"	"	Iron	and Brass	"	240
15	"	"	"	"	"	"	250
17½	"	"	"	"	"	"	290
20	"	"	"	"	"	"	325
22½	"	"	"	"	"	"	400
25	"	"	"	"	"	"	435
27½	"	"	"	"	"	"	500
30	"	"	"	"	"	"	550
32½	"	"	"	"	"	"	650
35	"	"	"	"	"	"	700
40	"	"	"	"	"	"	875
44	"	"	"	"	"	"	1100
48	"	"	"	"	"	"	1300
55	"	"	"	"	"	"	2000
60	"	"	"	"	"	"	2500

PRICE-LIST OF

"Cylinder Gate" Victor Turbines

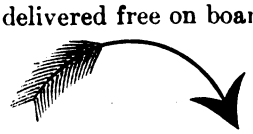
OF STANDARD PATTERN AND WEIGHT

As Illustrated on Page 38.

Size of Wheel.	List Price.	Sq. in. of water used.	Approximate Weight.
15 inch	$ 275.00	78	1070 lbs.
18 "	325.00	109	1650 "
21 "	375.00	153	2525 "
24 "	450.00	189	3250 "
27 "	525.00	252	4225 "
30 "	600.00	298	5325 "
33 "	700.00	377	6300 "
36 "	825.00	426	7750 "
39 "	975.00	524	8775 "
42 "	1150.00	624	11250 "
45 "	1350.00	701	12550 "
48 "	1600.00	773	14225 "
51 "	1900.00	873	21000 "
54 "	2250.00	1009	22475 "
57 "	quoted on application	1090	
60 "	" " "	1208	

In comparing above prices with prices of other Wheels, compare also the Power of the respective Wheels and compute the relative cost per Horse Power.

The above Price List is for wheels complete as shown on pages 38 and 39, delivered free on board cars at Dayton.



With the Sun, or Right Hand.

In ordering wheels, state whether they are to *run with the sun*, or *against the sun*.



Against the Sun, or Left Hand.

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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IRON PIPE FITTINGS.

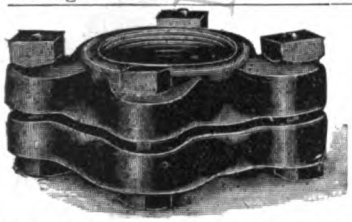
Piece Fittings.

BLACK.

Size, inches,		¼	⅜	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6
Unions,	Each,	$0.15	.18	.20	.28	.34	.46	.60	.80	1.50	2.10	3.00	4.00		
Plugs,	"	.03	.03	.04	.05	.06	.10	.13	.20	.35	.50	.75	.85	1.75	2.40
Bushings,	"	.05	.05	.06	.07	.09	.13	.17	.27	.42	.60	.80	1.00	1.85	2.50
Caps,	"	.03	.03	.05	.08	.11	.15	.22	.30	.50	.80	1.10	1.30	2.00	2.35
Nipples, short,	"	.05	.06	.07	.09	.10	.14	.17	.25	.56	.75	1.00	1.25	2.00	2.75
" long,	"	.07	.09	.10	.11	.15	.20	.25	.35	.75	.95	1.25	1.60	2.60	3.60
" ex.long,5 in.	"	.16	.17	.18	.20	.22	.29	.36	.44						
" " 6 "	"	.17	.18	.19	.21	.24	.31	.38	.49	.80	1.00				
" " 7 "	"	.18	.19	.20	.22	.27	.33	.40	.54	.85	1.06	1.38	1.75	2.75	3.75
" " 8 "	"	.19	.20	.21	.23	.29	.35	.42	.59	.91	1.15	1.50	1.92	2.95	3.90
Lock Nuts,	"	.04	.04	.06	.07	.08	.10	.12	.25	.40	.50	.70	.95	1.35	1.90
Wrought Sockets,	"	.05	.06	.07	.10	.13	.17	.21	.28	.40	.60	.80	1.00	1.65	2.40
45 deg. Elbows, Cast Iron,	Each					.20	.25	.35	.50	1.30	1.60	1 90	2.50		

GALVANIZED.

Size, inches,		¼	⅜	½	¾	1	1¼	1½	2	2½	3	3½	4
Unions,	Each	$0.20	.24	.27	.37	.50	.70	.90	1.20	2.25	2.90	4.50	5.60
Caps,	"	.05	.05	.07	.10	.14	.20	.30	.40	.65	1.00	1.30	1.60
Nipples, short	"	.07	.08	.09	.11	.13	.17	.23	.32	.65	.85	1.15	1.40
" long	"	.09	.11	.13	.16	.19	.24	.31	.40	.85	1.10	1.40	1.90
Wrought Sockets,	"	.06	.08	.10	.13	.18	.25	.32	.40	.55	.80	1.05	1.40



UNION FLANGES

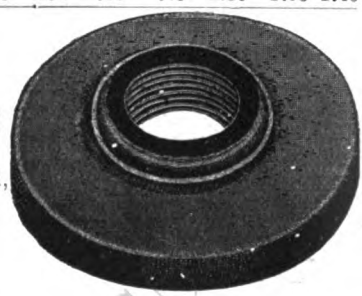
With Bolts

Size, inches,	¾	1	1¼	1½	2	2½	3
Per pair,	$0.65	.70	.85	1.15	1.50	1.75	2.25
Size, inches,	3½	4	5	6			
Per pair,	$2.75	3.15	5.00	6.50			

PLAIN FLANGES

Per Pound,

$0.12½



AVERAGE WEIGHT OF TEN PIECES.

Size of Pipe, inches,	¼	⅜	½	¾	1	1¼	1½	2	2½	3	3½	4
Elbows, pounds,	1	1½	2¼	4¼	6	9	13	22	41	55	62	110
Tees, "	1	1¾	2½	5	8	11	15	27	46	67	70	130
Sockets, "	¾	1¼	2	2½	4	7	9	12				
Crosses, "	1½	2	3½	4½	6	11	14	30	58	80	100	170
Reducers, "		1	1½	2	3½	5	7	10	20	35	50	60
Return Bends, "			4	10½	14	18	25	40				

NIPPLES—TABLE OF SIZES KNOWN AS SHORT AND LONG.

Size of Pipe, inches,	¼	¾	½	⅜	1	1¼	1½	2	2½	3	3½	4
Short, length, in.	¾ to 3½	1 to 1½	1 to 1½	1¼ to 2	1¼ to 2	1½ to 2½	1½ to 2½	2 to 2½	2½ to 3	2½ to 3	2½ to 4	3 to 4
Long, length, in.	2 to 3½	2 to 3½	2 to 3½	2½ to 4	2½ to 4	3 to 4½	3 to 4½	3 to 4½	3 to 5	3½ to 5	4½ to 6	4½ to 6

WEIGHT OF PLAIN FLANGES, STANDARD SIZES.

Size of Pipe, inches,	¾	1	1¼	1½	2	2½	3	3½	4
Diameter, inches,	4	5	6	6-7-8	7-7	8-9	8-9	10	10
Weight each, pounds,	1½	2½	3½	4-5-7	5-6½	8½-11	8-10½	13½	12½

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IRON PIPE FITTINGS



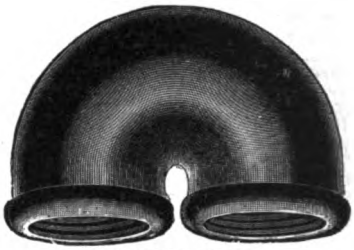
ELBOW



SOCKET



REDUCER



RETURN BEND



CROSS

POUND FITTINGS

CLASS A

BLACK, per pound, 25 cts.; GALVANIZED, 35 cts.

Elbows and Tees, $\frac{1}{8}$, $\frac{1}{8}$x$\frac{1}{4}$, $\frac{1}{4}$x$\frac{1}{8}$, $\frac{3}{8}$x$\frac{1}{8}$ inch.

Reducers, $\frac{1}{4}$x$\frac{1}{8}$, $\frac{3}{8}$x$\frac{1}{8}$ inch.

Sockets, $\frac{1}{8}$ inch.



LOCK NUT.

CLASS B

BLACK, per pound, 16 cts; GALVANIZED, 23 cts.

Elbows and Tees, $\frac{1}{4}$ to $\frac{1}{2}$ inch, inclusive.

Street Elbows, to $\frac{3}{4}$ inch, inclusive.

Crosses, to 1 inch, inclusive.

Drop Elbows and Tees, all sizes.

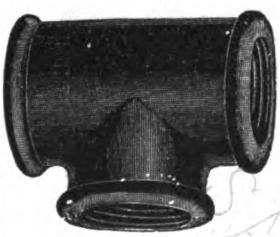
Reducers, $\frac{3}{8}$x$\frac{1}{4}$ to 1 inch inclusive.

Sockets, $\frac{1}{4}$ to $\frac{3}{4}$ inch, inclusive.

Return bends, to 1 inch, inclusive.



UNION



TEE

CLASS C

BLACK, per pound, 13 cts.; GALVANIZED, 20 cts.

Elbows and Tees, $\frac{3}{4}$ to 1 inch, inclusive.

Crosses, $\frac{1}{4}$ inch and larger.

☞Such of the above that have outlets, smaller than $\frac{3}{4}$ inch to be classed as "B," and so priced.

Street Elbows, 1 inch and larger.

Reducers, $1\frac{1}{4}$ inch and larger.

Sockets, 1 and $1\frac{1}{4}$ inch.

Return Bends, $1\frac{1}{4}$ inch and larger.



45 DEGREE ELBOW

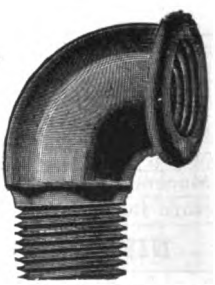
CLASS D

BLACK, per pound, 10 cts.; GALVANIZED, 17 cts.

Elbows and Tees, $1\frac{1}{4}$ inch and larger.

☞Such of the above that have outlets smaller than 1 inch to be classed as "C," and so priced.

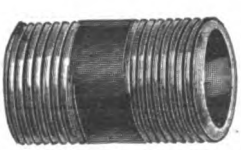
Sockets, $1\frac{1}{2}$ to 2 inch.



STREET ELBOW



PLUG



SHOULDER NIPPLE



CAP



CLOSE NIPPLE



BUSHING

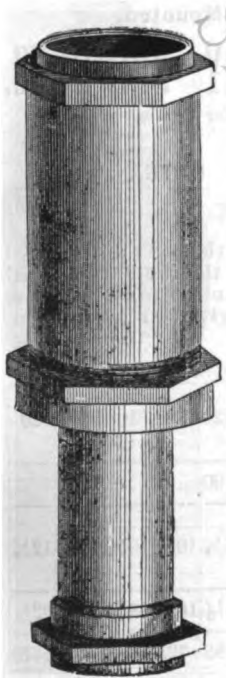
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AVERAGE WEIGHT OF TEN PIECES OF MALLEABLE PIPE FITTINGS.

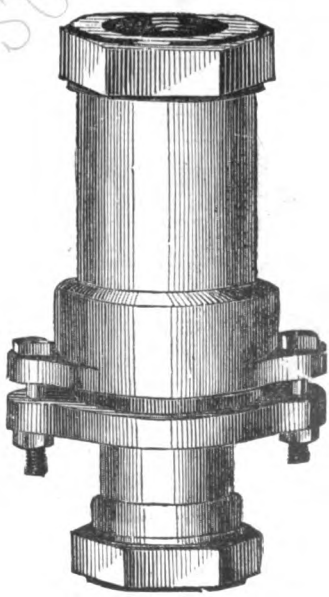
BEADED PATTERN FOR STEAM OR WATER

Size of pipe, inches.	Elbows, lbs.	Tees, lbs.	Sockets, lbs	Crosses, lbs.	Reducers, lbs.	Return Bends, lbs.	NIPPLES. Table of sizes known as Short and Long. SHORT, Measure as follows.	NIPPLES. LONG, Measure as follows.	WEIGHT Of Plain Pipe Flanges Standard Sizes. Diameter, inches.	Weight, each, pounds.
¼	1	1	¾	1½	.....	.....	¾ to 1½	2 to 3½	.....	.....
⅜	1½	1¾	1¼	2	1	.....	1 to 1½	2 to 3½	.....	.....
½	2¼	2½	2	3½	1½	4	1 to 1½	2 to 3½	.....	.....
¾	4¼	5	2½	4½	2	10½	1¼ to 2	2½ to 4	4	1½
1	6	8	4	6	3½	14	1½ to 2	2½ to 4	5	2½
1¼	9	11	7	11	5	18	1½ to 2½	3 to 4½	6	3½
1½	13	15	9	14	7	25	1½ to 2½	3 to 4½	6	4
									7	5
									8	7
2	22	27	12	30	10	40	2 to 2½	3 to 4½	7	5
									8	6½
2½	41	46	.....	58	20	.....	2½ to 3	3 to 5	8	8½
									9	11
3	55	67	.....	80	35	.....	2½ to 3	3½ to 5	8	8
									9	10½
3½	62	70	.....	100	50	.....	2½ to 4	4½ to 6	10	13½
4	110	130	.....	170	60	.....	3 to 4	4½ to 6	10	12½

EXPANSION JOINTS.



STEAM METAL. Size, Inchs	STEAM METAL. Price, Each.	IRON BODY. Size, Inchs	IRON BODY. Price, Each.	IRON BODY. Screwed or Flanged Ends. Size, Inchs	IRON BODY. Screwed or Flanged Ends. Price, Each.
¾	$2 00	2	$10 00	2½	$13 50
1	2 75	2½	12 00	3	18 00
1¼	4 00	3	16 00	3½	26 50
1½	5 50	3½	24 00	4	31 00
2	8 00	4	28 00	5	44 00
2½	16 00	5	40 00	6	55 00
3	24 00	6	50 00	8	80 00

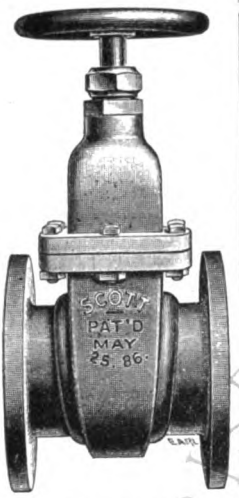


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SCOTT GATE VALVE.

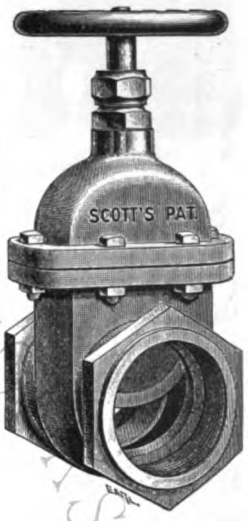
IRON BODY, BRASS MOUNTED.

Flanged or Screwed End. **Also all Iron Valves.**



Flange End.

Size, Inches.	Price.	Screwed End. Face to Face.	Screwed End, Finished Weight, Lbs.	Flanged End. Face to Face.	Flanged End, Finished Weight, Lbs.	Flanged End, Diameter of Flange.
2	$ 9.00	5 3/8	12	6	18	6
2 1/2	12.00	6 1/4	23	6 3/4	32	7
3	15.00	7 1/8	30	7 3/8	38	7 1/2
3 1/2	18.00	7 3/4	36	8 1/8	50	8 1/2
4	20.00	9	52	8 3/4	60	9
4 1/2	23.00	8 3/4	58	8 7/8	78	9 1/2
5	25.00	9 3/8	70	9 1/8	90	10
6	30.00	10 3/4	105	10 3/4	135	11
7	40.00	11	145	11	165	13
8	50 00	12 1/8	200	12 1/8	218	14
10	65 00	13 1/4	300	13 1/2	305	16
12	90 00	.....	.....	14 5/8	475	19
14	.....	.....	.....	16 1/2	745	21
16	.....	.....	.....	19 1/4	1100	23
18	.....	.....	.....	19 3/4	1500	25
20	.....	.....	.....	24 1/8	1950	27



Screw End.

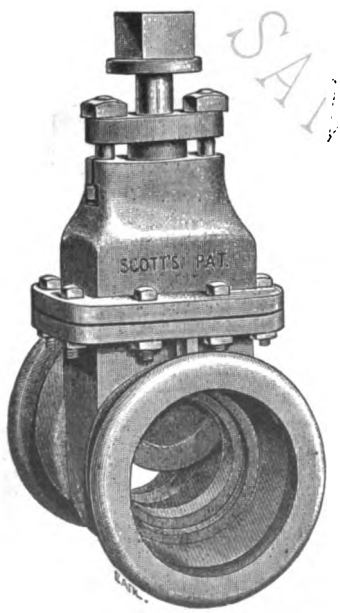
These valves are of the kind known as "**DOUBLE DISK GATE VALVES,**" and have been designed with a special view to strength and compactness. They are remarkable for simplicity of construction. Please be particular when ordering valves to give full description in every respect.

SCOTT'S

Patent Iron Body, Brass Mounted,

BELL ENDS, STATIONARY SPINDLES.

All Spindles made of best Phosphor Bronze.



WATER GATE EXTRA HEAVY

(Patented May 25, 1886.)

All Water Gates open by turning to the LEFT; if desired we can make them to open by turning to the right. All tested to 300 pounds water pressure, and guaranteed to be first-class in every respect. Prices for large sizes given on application. We make these WITH OR WITHOUT GEARS.

DIMENSIONS IN INCHES.

Size.....	3	4	6	8	10	12	14	16	18	20
Price.....	$15	20	30	50	65	90	....	....	....	....
End to end of pipe when laid in Bell.....	4	5 1/4	6 1/2	7	8	8 1/2	10 1/4	10 1/2	11 3/4	12 1/2
Dia. bell sock't	4 5/8	5 3/4	7 7/8	10	12	14 1/8	16 1/4	18 1/4	20 5/8	22 3/4
Fin. Weight...	42	72	145	230	318	495	725	1090	1495	1720

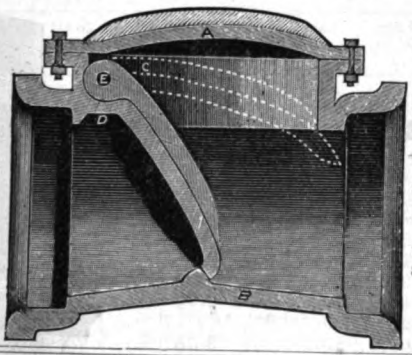
ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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SCOTT'S IRON CHECK VALVES

HUB AND FLANGE END.

Corporations and contractors will readily perceive from cut of above valve that it is so constructed as to be free from any disadvantage possessed by many ordinary kinds now in use.



Sand and gravel cannot remain in the lower part of the valve, as the current will always carry outward any obstruction that would have a tendency to lodge. All working parts and face are made of composition.

Size, Inches.	Flange Ends. Price.	Hub Ends, Price.	Distance, End to End of Pipe in Hub.	Distance, Face to Face, Flanged.	Diameter of Flanges.	Finished Weight, Flanged End.	Finished Weight. Bell End.
3	$ 18.00	$ 16.00	8¼	8¼	7½	40	45
4	21.00	20.00	10	10¾	9	58	61
6	31.00	30.00	12½	14	11	122	130
8	50.00	50.00	13½	16¾	14	200	200
10	76.00	76.00	15	18¼	16	290	295
12	95.00	90.00	18	22¾	19	500	485
16	128.00	120.00	....	....	....	....	....
20	228.00	220.00	....	....	....	....	....
24	320.00	300.00	....	....	....	....	....
30	.....	.....	....	....	....	....	....



SCOTT'S

STRAIGHT-WAY GATE VALVE.

THE BEST IN THE WORLD *BEST STEAM METAL*

ALL BRASS

Size, inches....	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6
Price, Screwed ends.....	$1.30	1.75	2.50	3.50	5.00	7.50	15.00	22.00	....	....	.....	.....
Price, Flanged Ends.... ...	.....	....	.....	.....	.....	15.00	25.00	30.00	.....	.....	.....	....
Diameter of Flanges	.....	.. .	....	.....	.....	6	7	7½	8½	9	10	11
Face to Face, Screwed Ends.	2⅜	2½	2⅞	3¼	3½	4⅛	4½	4⅞	6⅛	6¾	.....	....
Face to Face, Flanged Ends.	....	.....	.....	.....	.....	5⅓	6⅜	7⅛	7¾	8½	8¾	10⅜

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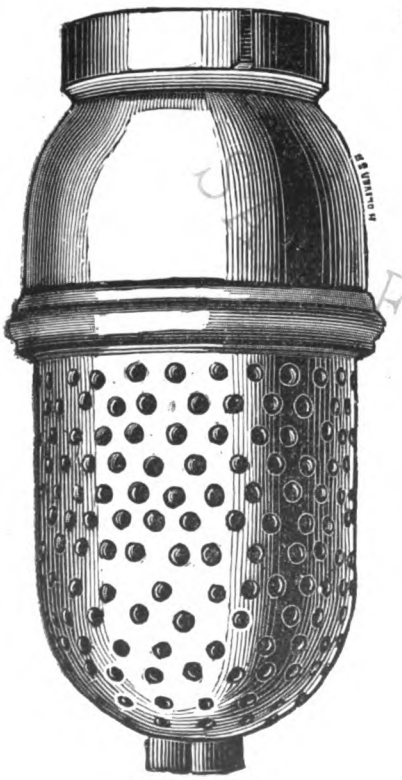
FOOT VALVES AND STRAINERS.

BRASS

Size, Inches.	Price, Each.
¾	$1 50
1	2 00
1¼	2 75
1½	3 75
2	5 50
2½	10 00
3	13 00







IRON

Size, Inches.	Price, Each. Screwed.	Flanged.*
¾	$ 1 00	.....
1	1 50	.....
1¼	1 75	.....
1½	2 50	.....
2	3 50	.....
2½	5 50	.....
3	7 00	$ 7 00
3½	11 00	11 00
4	13 75	13 75
5	17 50	17 50
6	24 00	24 00
8	38 00	38 00

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CAST-IRON PIPE

Safe Thickness of Metal and Weight per Length, including Bells, for Different Sizes and under Various Heads of Water

Size. Inside Diam.	25 ft. Head or 10.82 lbs. Pressure		50 ft. Head or 21.65 lbs. Pressure		100 ft. Head or 43.30 lbs. Pressure		150 ft. Head or 64.95 lbs. Pressure		200 ft. Head or 86.60 lbs. Pressure		250 ft. Head or 108.25 lbs. Pressure		300 ft. Head or 129.90 lbs. Pressure		Contents in Gallons for 1 ft. in Length
	Thickness of Metal	Weight per Length	Thickness of Metal	Weight per Length	Thickness of Metal	Weight per Length	Thickness of Metal	Weight per Length	Thickness of Metal	Weight per Length	Thickness of Metal	Weight per Length	Thickness of Metal	Weight per Length	
2	.255	54	.294	63	.312	67½	.330	72	.348	76½	.366	81	.384	86	.163
3	.320	132	.344	144	.353	149	.362	153	.371	157	.380	161	.390	166	.367
4	.335	180	.361	197	.373	204	.385	211	.397	218	.409	226	.421	235	.652
6	.375	300	.393	315	.411	330	.429	345	.447	361	.465	277	.483	393	1.469
8	.433	456	.422	445	.450	475	.474	502	.498	529	.522	557	.546	584	2.611
10	.442	576	.459	600	.489	641	.519	682	.549	723	.579	766	.609	808	4.081
12	.446	720	.491	768	.527	826	.563	885	.599	944	.635	1004	.671	1064	5.876
14			.524	952	.566	1031	.608	1111	.650	1191	.692	1272	.734	1352	7.997
16			.580	1215	.604	1253	.652	1360	.700	1463	.748	1568	.796	1673	10.44
18			.589	1370	.643	1500	.697	1630	751	1761	.805	1894	.859	2026	13.22
20			.622	1603	.682	1763	.742	1924	.802	2086	.862	2248	.922	2412	16.32
24			.687	2120	.759	2349	.831	2580	.903	2811	.975	3045	1.047	3279	23.50
30			.785	3020	.875	3376	.965	3785	1.055	4095	1.145	4458	1.235	4822	36.72
36			.882	4070	.990	4581	1.098	5096	1.206	5613	1.314	6133	1.422	6656	52.88
48			1.078	6616	1.222	7521	1.366	8431	1 510	9340	1.654	10269	1.798	11195	94.02

All pipes cast in lengths of 12 feet, except the 2 inch, which are cast 9 feet long.

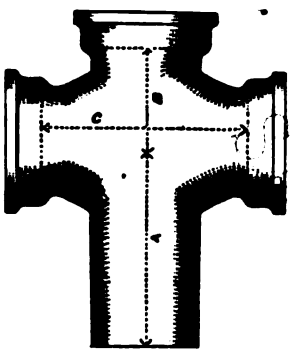
Pipes with flanges weigh about 15 per cent more than above

Packing of Rubber for flanged pipe is usually ⅛ inch thick and weighs about 10 lbs. to the square yard.

Doubling the diameter of a pipe increases its capacity four times. About 60 gallons of water per day to each inhabitant is usually considered a fair ample allowance in large cities. A gallon of water contains 231 cubic inches and weighs 8⅓ lbs. U. S. standard. A cubic foot contains 7⅓ gallons and weighs 62½ lbs. U. S. standard.

CAST IRON PIPE FITTINGS

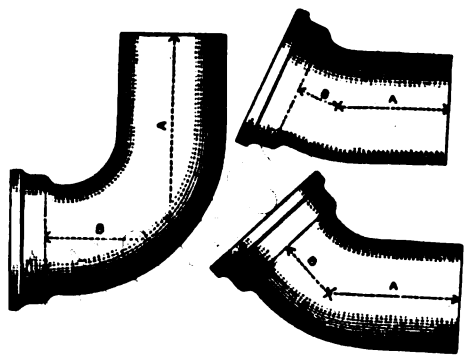
CROSSES.



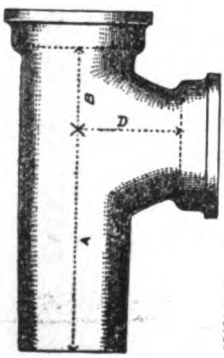
DIMENSIONS OF CROSSES

D'm. in.	A. in.	B. in.	C. in.
3	18	8	15
4	18	8	15
5	20	9	17
6	20	9	17
8	22	10	20
10	24	11	23
12	26	12	26
14	28	13	29
16	30	14	32
18	32	15	35
20	34	16	38
24	36	20	44

BENDS.



TEES.



DIMENSIONS OF TEES

Diam. in.	A. in.	B. in.	D. in.
3	18	8	7½
4	18	8	7½
5	20	9	8½
6	20	9	8½
8	22	10	10
10	24	11	11½
12	26	12	13
14	28	13	14½
16	30	14	16
18	32	15	17½
20	34	16	19
24	36	20	22

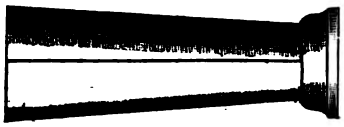
DIMENSIONS OF BENDS

Diam. in.	90° A. in.	90° B. in.	45° A. in.	45° B. in.	22½° A. in.	22½° B. in.
3	17	7	10	4	8	3
4	18	8	11	4	9	3
5	19	9	12	5	10	3
6	20	19	13	5	11	4
8	22	12	14	6	12	4
10	24	14	15	7	13	5
12	26	16	16	8	14	5
14	28	18	17	9	15	6
16	30	20	18	10	16	6
18	32	22	19	11	17	7
20	34	24	20	12	18	7
24	38	28	22	14	20	8

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CAST IRON PIPE FITTINGS.

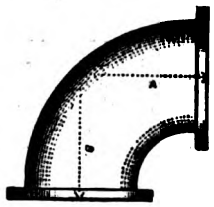
REDUCERS



DIMENSIONS OF REDUCER

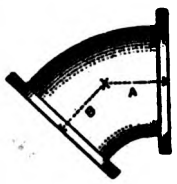
A.			A.			A.		
4	to 3	26	12	to 8	38	18	to 8	47
5	" 4	29	12	" 6	38	20	" 18	50
5	" 3	29	14	" 12	41	20	" 16	50
6	" 5	29	14	" 10	41	20	" 14	50
6	" 4	29	14	" 8	41	20	" 12	50
6	" 3	29	14	" 6	41	20	" 10	50
8	" 6	32	16	" 14	44	20	" 8	50
8	" 5	32	16	" 12	44	24	" 20	56
8	" 4	32	16	" 10	44	24	" 18	56
8	" 3	32	16	" 8	44	24	" 16	56
10	" 8	35	18	" 16	47	24	" 14	56
10	" 6	35	18	" 14	47	24	" 12	56
10	" 5	35	18	" 12	47	24	" 10	56
12	" 10	38	18	" 10	47			

FLANGED BENDS



DIMENSIONS OF BENDS
90°

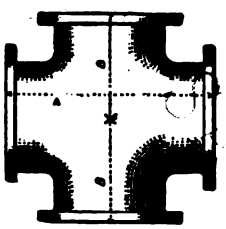
Diam. in.	A. in.	B. in.
3	7	7
4	8	8
5	9	9
6	10	10
8	12	12
10	14	14
12	16	16
14	18	18
16	20	20
18	22	22
20	24	24
24	28	28



DIMENSIONS OF BENDS
45°

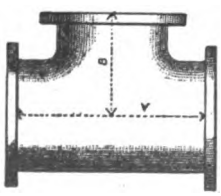
Diam. in.	A. in.	B. in.
3	4	4
4	4	4
5	5	5
6	5	5
8	6	6
10	7	7
12	8	8
14	9	9
16	10	10
18	11	11
20	12	12
24	14	14

FLANGED BRANCHES.



DIMENSION OF CROSSES

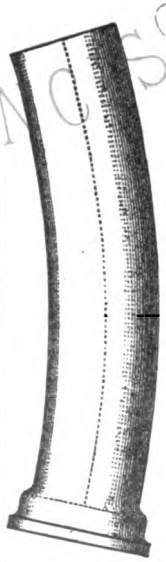
Diam. in.	A. in.	B. in.
3	13½	6¾
4	15	7½
5	16½	8¼
6	18	9
8	21	10½
10	24	12
12	27	13½
14	30	15
16	33	16½
18	36	18
20	39	19½
24	45	22½



DIMENSIONS OF TEES

Diam. in.	A. in.	B. in.
3	13½	6¾
4	15	7½
5	16½	8¼
6	18	9
8	21	10½
10	24	12
12	27	13½
14	30	15
16	33	16½
18	36	18
20	39	19½
24	45	22½

CURVES



Diam. in.	Radius. ft. in.	Diam. in.	Radius. ft. in.
3	2 0	14	10 0
4	10 0	14	15 0
4	20 0	14	20 0
4	2 0	16	4 0
6	2 6	16	7 0
6	4 0	16	8 0
6	10 0	16	16 0
6	12 0	16	20 0
6	20 0	18	3 6
8	6 0	18	10 0
8	12 0	18	12 0
8	20 0	18	20 0
10	24 0	20	5 0
10	5 0	20	15 0
10	20 0	20	20 0
10	30 0	20	50 0
10	50 0	24	5 0
12	2 5	24	20 0
12	5 0	24	50 0
12	6 0	24	100 0
12	10 0	30	3 0
12	15 0	30	4 0
12	25 0	30	20 0
12	30 0	36	20 0
12	50 0	36	50 0
14	2 4	42	50 0
14	5 0	48	50 0

RISDON IRON WORKS
SAN FRANCISCO

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Table of Approximate Weight of Pipe Fittings.

CROSSES	FOR WATER	FOR GAS
3x 3x 3x 3	75 lbs	60 lbs
4x 4x 4x 4	120 "	105 "
4x 4x 3x 3	109 "	90 "
6x 6x 6x 6	225 "	175 "
6x 6x 4x 4	200 "	160 "
6x 6x 3x 3	175 "	150 "
8x 8x 8x 8	325 "	300 "
8x 8x 6x 6	285 "	265 "
8x 8x 4x 4	255 "	230 "
8x 8x 3x 3	205 "	.....
10x10x10x10	565 "	.....
10x10x 8x 8	425 "	.....
10x10x 6x 6	385 "	.....
10x10x 4x 4	350 "	.....
10x10x 3x 3	333 "	.....
12x12x12x12	713 "	.....
12x12x10x10	645 "	.....
12x12x 8x 8	560 "	.....
12x12x 6x 6	495 "	.....
12x12x 4x 4	480 "	.....

TEES	FOR WATER	FOR GAS
3x 3x 3	60 lbs	50 lbs
4x 4x 4	115 "	85 "
4x 4x 3	85 "	80 "
6x 6x 6	190 "	150 "
6x 6x 4	155 "	110 "
6x 6x 3	140 "	95 "
8x 8x 8	260 "	210 "
8x 8x 6	250 "	200 "
8x 8x 4	235 "	185 "
8x 8x 3	190 "	160 "
10x10x10	430 "	.....
10x10x 8	350 "	.....
10x10x 6	320 "	.....
10x10x 4	297 "	.....
12x12x12	540 "	.....
12x12x10	505 "	.....
12x12x 8	460 "	.....
12x12x 6	440 "	.....
12x12x 4	420 "	.....

SLEEVES	FOR WATER	FOR GAS
3 inches.....	24 lbs	20 lbs
4 "	40 "	25 "
6 "	70 "	55 "
8 "	120 "	75 "
10 "	150 "	113 "
12 "	200 "	145 "
15 "	.....	.....
16 "	300 "	.....
20 "	450 "	.....

REDUCERS	FOR WATER	FOR GAS
4 to 3 in.	50 lbs	35 lbs
6 " 4 "	109 "	95 "
6 " 3 "	104 "	80 "
8 " 6 "	153 "	130 "
8 " 4 "	138 "	100 "
8 " 3 "	120 "	90 "
10 " 8 "	201 "	.....
10 " 6 "	170 "	.....
10 " 4 "	155 "	.....
12 " 10 "	300 "	.....
12 " 8 "	250 "	.....
12 " 6 "	225 "	.....

ELBOWS	FOR WATER	FOR GAS
3 inches.....	40 lbs	35 lbs
4 "	70 "	60 "
6 "	102 "	94 "
8 "	205 "	144 "
10 "	260 "	230 "
12 "	450 "	295 "
15 "	.....	.....
16 "	550 "	.....
20 "	1200 "	.....

BENDS	FOR WATER	FOR GAS
3 inches.....	50 lbs	33 lbs
4 "	80 "	70 "
6 "	133 "	117 "
8 "	201 "	190 "
10 "	300 "	220 "
12 "	440 "	310 "
15 "	.....	.....
16 "	730 "	.....
20 "	1425 "	.....

PLUGS	FOR WATER	FOR GAS
3 inches.....	8 lbs	6 lbs
4 "	12 "	9 "
6 "	20 "	18 "
8 "	40 "	28 "
10 "	60 "	40 "
12 "	90 "	70 "
15 "	.....	.....
16 "	180 "	.....
20 "	210 "	.....

As to flexible joints, bench castings and all other iron work for water and gas works, full information will be gladly furnished on application.

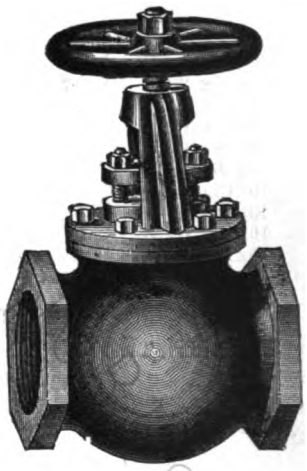
RISDON IRON WORKS SAN FRANCISCO

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GLOBE VALVE WITH YOKE

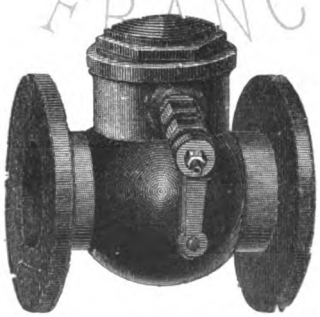
IRON BODY, BRASS MOUNTED

Size, Inches.	Iron Stem.		Brass Stem	
	Flange Ends	Screw Ends	Flange Ends	Screw Ends
2	$ 8 00	$ 6 00	$ 8 25	$ 7 00
2½	10 50	9 00	11 50	10 00
3	15 00	13 00	16 00	14 00
3½	18 00	15 50	19 50	17 00
4	23 00	20 00	25 00	22 00
4½	29 00	25 00	32 00	28 00
5	36 00	32 00	39 00	35 00
6	47 00	42 00	51 00	43 00
7	75 00	70 00	81 00	76 00
8	96 00	90 00	103 00	97 00
10	172 00	165 00	180 00	173 00
12	250 00	.....	262 00	.....



BACK PRESSURE VALVE

IRON BODY



Size, inches....	2	2½	3	4	5	6	7	8
Flange Ends....	....	....	$14.00	19.00	26.00	35.00	47.00	60.00
Screw Ends.....	$9.00	10.50	12.00	16.00	....	....	....	....

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WATER GATE

Brass Valve and Seat, Iron Body, Bell or Flanged Ends for Heavy Pressure.

Size, Inches.	Weight, Lbs.	Price.
3	74	$30
4	105	35
5	132	40
6	185	45
7	275	50
8	307	55
9	370	70
10	420	90
12	784	125
14	926	160
16	1450	230
18	1950	350
22	2450	400
24	3225	500
30		900

Light, for Pressure up to 100 Pounds.

Size, Inches.	Weight, Lbs.	Price.
3	54	$ 13 00
3½	63	14 50
4	69	16 00
5	107	20 00
6	140	25 00
7	220	35 00
8		40 00
10		70 00
12		88 00

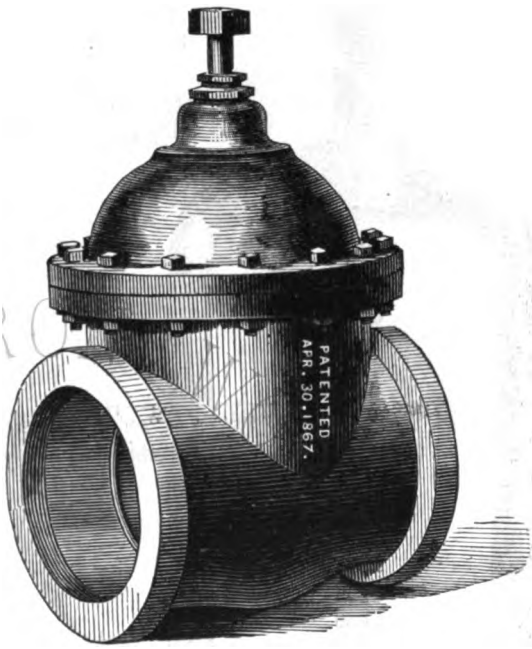


Fig. 44.

LIGHT WATER GATE

Iron Valve and Seat, Bell Ends

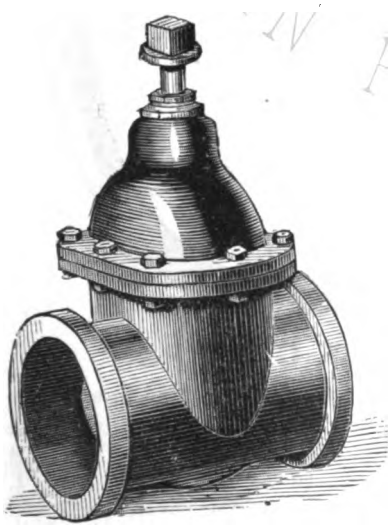
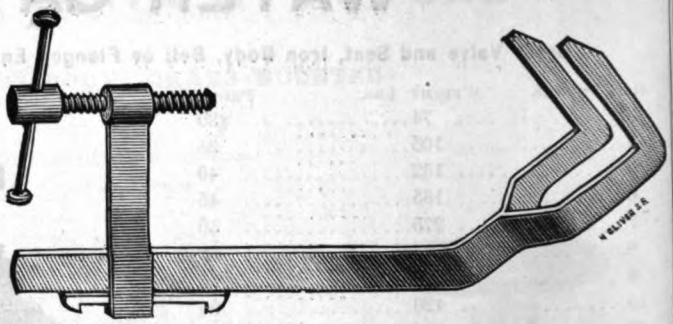


Fig. 45.

Size, Inches.	Weight, Lbs.	Price.
3	56	$18
4	98	20
5	114	25
6	130	30
7	175	35
8	210	40
10	340	65
12	462	85
16	870	120

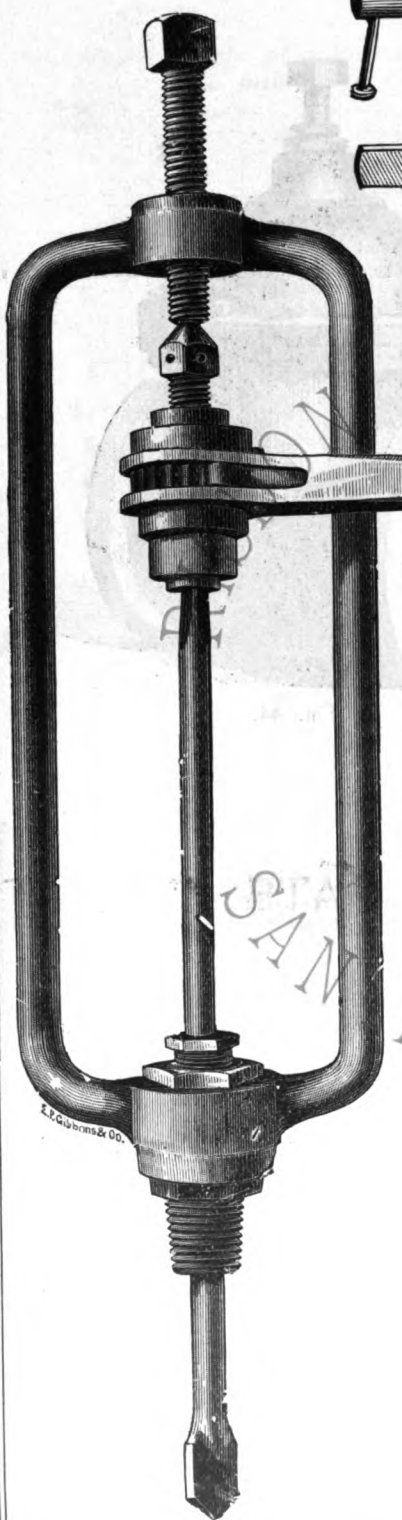
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CROW

For Drilling and Tapping Street Mains

No. 1, for sizes	1½ to 3 inches	$10 00
No. 2, "	1½ to 6 "	13 00
No. 3, "	1½ to 12 "	16 00



CHABOT DRILL

For Tapping Street Mains

Price	$30 00
Price of Drills	1 00
Size of Drills, inches	½, ¾, 1, 1¼



PIPE CLAMPS

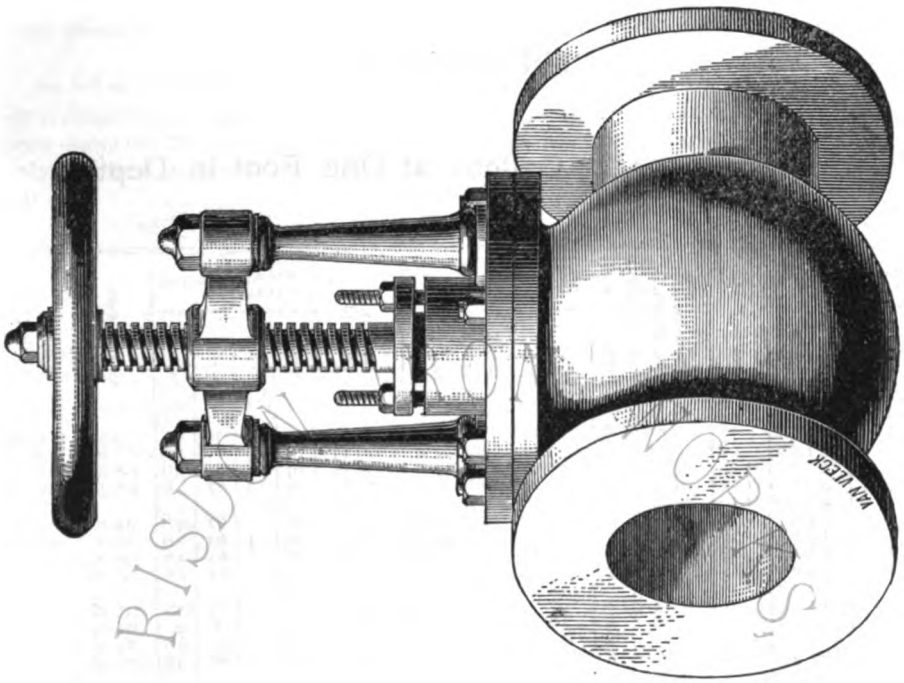
Or Saddle for Tapping Water and Gas Mains

Size of Clamp Tapped	⅛ to 1½ inches					
Pipe, inches	2	2½	3	3½	4	4½
Pipe, each	$ .75	.80	1.00	1.00	1.00	1.25
Pipe, inches	5	5½	6	7	8	
Price, each	$1.25	1.25	1.50	1.75	2.00	

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FLANGE GLOBE VALVE

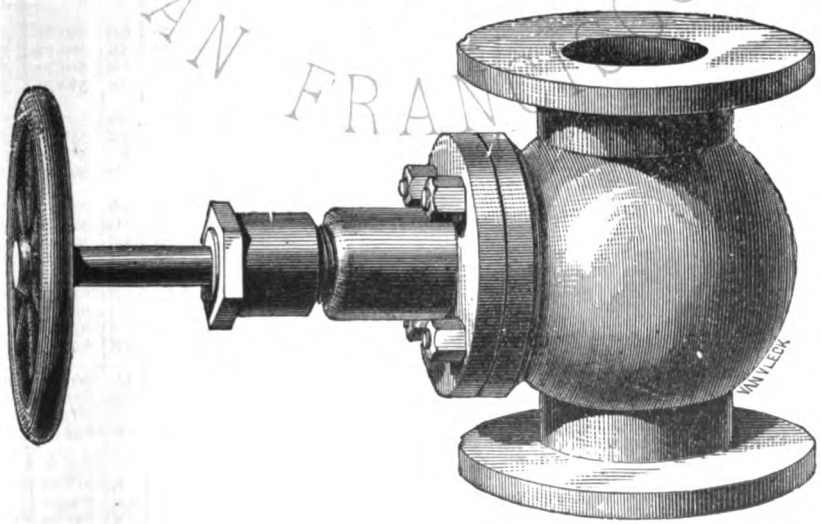
OUTSIDE SCREW—EXTRA



SIZE	3½	4	5	6	8	10	12
PRICE, each.....	$40	50	70	100	125	175	250

IRON FLANGE GLOBE VALVE

EXTRA



SIZE.....	1½	2	2½	3	3½	4	5	6
PRICE, each.....	$6	9	16	25	30	35	60	90

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Diameters, Circumferences and Areas of Circles,

IN FEET,

And Contents in Gallons at One Foot in Depth.

Diameter.		Circum.		Area in Feet.	Gallons, 1 Ft. Depth.	Diameter.		Circum.		Area in Feet.	Gallons, 1 Ft. Depth.	Diameter.		Circum.		Area in Feet.	Gallons, 1 Ft. Depth.
Feet.	Inches.	Feet.	Inches.			Feet.	Inches.	Feet.	Inches.			Feet.	Inches.	Feet.	Inches.		
1		3	1⅜	.78	5 87	6		18	10⅛	28.27	211.44	19		59	8¼	283.52	2120.34
1	1	3	4⅜	.92	6.89	6	3	19	7½	30 67	229.43	19	3	60	5⅜	291.03	2176.51
1	2	3	8	1.06	7 99	6	6	20	4⅞	33.18	218.15	19	6	61	3⅛	298.64	2233.29
1	3	3	11	1.22	9.17	6	9	21	2⅛	35.78	267.61	19	9	62	⅛	306.35	2291.04
1	4	4	2⅛	1.39	10.44												
1	5	4	5⅜	1.57	11.78	7		21	11⅞	38.48	287.80	20		62	9⅞	314.16	2349.41
1	6	4	8½	1.76	13 21	7	3	22	9¼	41.28	308.72	20	3	63	7⅜	322.06	2408.51
1	7	4	11⅝	1.96	14 72	7	6	23	6¾	44.17	330.38	20	6	64	4¾	330.06	2468.35
1	8	5	2¾	2.18	16.31	7	9	24	4⅛	47.17	352 76	20	9	65	2¼	338.16	2528.92
1	9	5	5⅞	2.40	17.98												
1	10	5	9	2.63	19.74	8		25	1⅛	50.26	375.90	21		65	11⅜	346.36	2590.22
1	11	6		2.88	21.48	8	3	25	11	53.45	399.76	21	3	66	9	354 65	2652.25
						8	6	26	8⅛	56.74	424.36	21	6	67	6⅛	363.05	2715.04
2		6	3¼	3.14	23.49	8	9	27	5¼	60.13	449.21	21	9	68	3⅜	371.54	2778.54
2	1	6	6½	3.40	25.49												
2	2	6	9⅝	3.68	27.57	9		28	3¼	63.61	475.75	22		69	1⅜	380.13	2842.79
2	3	7	¾	3.97	29.73	9	3	29	⅜	67.20	502.55	22	3	69	10¾	388.82	2907.76
2	4	7	3⅛	4 27	32.69	9	6	29	10⅛	70.88	530.08	22	6	70	8¼	397.60	2973.48
2	5	7	7	4 58	34.30	9	9	30	7½	74.66	558.35	22	9	71	5⅝	406.49	3039.92
2	6	7	10¼	4.90	36.70												
2	7	8	1⅜	5.24	39.19	10		31	5	78.54	587.35	23		72	3	415.47	3107.10
2	8	8	4½	5.58	41.76	10	3	32	2⅛	82.51	617.08	23	3	73	⅛	424.55	3175.01
2	9	8	7⅝	5.93	44.41	10	6	32	11¼	86.59	647.55	23	6	73	9⅞	433.73	3243.65
2	10	8	10¾	6.30	47.15	10	9	33	9¼	90.76	678.27	23	9	74	7¼	443 01	3313.04
2	11	9	1⅞	6.68	49.96												
						11		34	6⅝	95.03	710.69	24		75	4¼	452.39	3383.15
3		9	5	7.06	52.86	11	3	35	4⅛	99.40	743.36	24	3	76	2⅛	461.86	3454.00
3	1	9	8¼	7.46	55.83	11	6	36	1½	103.86	776 77	24	6	76	11⅝	471.43	3525.59
3	2	9	11⅜	7.87	58.89	11	9	36	10⅜	108.43	810.91	24	9	77	9	481.10	3597.90
3	3	10	2½	8.29	62.03												
3	4	10	5⅝	8.72	65.26	12		37	8⅜	113.09	848.18	25		78	6⅛	490.87	3670.95
3	5	10	8¾	9.16	68.51	12	3	38	5¼	117 85	881.39	25	3	79	3⅜	500.74	3744.74
3	6	10	11⅞	9.62	73.15	12	6	39	3¼	122.71	917.73	25	6	80	1¼	510.70	3819.26
3	7	11	3	10 08	75.41	12	9	40	⅜	127.67	954.81	25	9	80	10¾	520.76	3894.52
3	8	11	6⅛	10.55	78.96												
3	9	11	9⅜	11 04	82 59	13		40	10	132.73	992.62	26		81	8⅛	530.93	3970 50
3	10	12	½	11.54	86.30	13	3	41	7¼	137.88	1031.17	26	3	82	5¼	541.18	4047.23
3	11	12	3⅜	12.04	90.10	13	6	42	4⅜	143.13	1070.45	26	6	83	3	551.54	4124.68
						13	9	43	2¼	148.48	1108.06	26	9	84	⅜	562.00	4202.96
4		12	6¼	12.56	93.97												
4	1	12	9⅛	13 09	97.93	14		43	11¼	153.93	1151.21	27		84	9⅜	572.55	4281.80
4	2	13	1	13 63	101 97	14	3	44	9⅛	159.48	1192.69	27	3	85	7⅛	583.20	4361.46
4	3	13	4⅛	14.18	103 03	14	6	45	6⅜	165.13	1234.91	27	6	86	4⅜	593 95	4441 86
4	4	13	7¼	14.74	110.29	14	9	46	4	170.87	1277.86	27	9	87	2⅛	604.80	4522.98
4	5	13	10½	15.32	114.57												
4	6	14	1⅜	15.90	118.93	15		47	1⅛	176.71	1321.54	28		87	11½	615.75	4604.85
4	7	14	4⅝	16.49	123.38	15	3	47	10⅞	182.65	1365.96	28	3	88	9	626.79	4686 48
4	8	14	7⅞	17.10	127.91	15	6	48	8¼	188.69	1407.51	28	6	89	6⅛	637.94	4770.77
4	9	14	11	17 72	132.52	15	9	49	5¼	194.82	1457.00	28	9	90	3¼	649.18	4854.84
4	10	15	2⅜	18.34	137.21												
4	11	15	5¼	18.98	142.05	16		50	3⅛	201.06	1503.62	29		91	1¼	660.52	4939.64
						16	3	51	½	207.39	1550.97	29	3	91	10⅝	671.95	5025.17
5		15	8½	19.63	146.83	16	6	51	10	213.82	1599 06	29	6	92	8¼	683.49	5111.41
5	1	15	11⅜	20.29	151.77	16	9	52	7⅜	220.35	1647.89	29	9	93	5½	695 12	5198.44
5	2	16	2¼	20.96	156.78												
5	3	16	5¼	21.64	161.88	17		53	4⅞	226.98	1697.45	30		94	2¾	706 86	5286.18
5	4	16	9	22.34	167.06	17	3	54	2⅛	233.70	1747.74	30	3	95	⅜	718 69	5374 65
5	5	17	⅛	23.04	172.33	17	6	54	11⅜	240 52	1798 76	30	6	95	9¾	730.61	5463 85
5	6	17	3¼	23.75	177 67	17	9	55	9⅛	247.45	1850.53	30	9	96	7¼	742 64	5553.79
5	7	17	6⅜	24.48	183.09												
5	8	17	9⅜	25.21	188.60	18		56	6½	254.46	1903 02						
5	9	18	¼	25.96	194.19	18	3	57	4	261.58	1956 25						
5	10	18	3⅛	26.72	199 86	18	6	58	1⅜	268.80	2010 21						
5	11	18	7⅛	27.49	205 61	18	9	58	10¾	276 11	2064.91						

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U. S. STANDARD GAUGE FOR SHEET AND PLATE IRON AND STEEL.

Approved March 3, 1893. (COPY) [PUBLIC—No. 137.]

An Act establishing a standard gauge for sheet and plate iron and steel.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That for the purpose of securing uniformity the following is established as the only standard gauge for sheet and plate iron and steel in the United States of America, namely:

Numbers of Gauge.	Approximate Thickness in Fractions of an Inch.	Approximate Thickness in Decimal Parts of an Inch.	Weight per Square Foot in Ounces Avoirdupois	Weight per Square Foot in Pounds Avoirdupois.
0000000	1-2	.5	320	20.00
000000	15-32	.46875	300	18.75
00000	7-16	.4375	280	17.50
0000	13-32	.40625	260	16.25
000	3-8	.375	240	15.
00	11-32	.34375	220	13.75
0	5-16	.3125	200	12.50
1	9-32	.28125	180	11.25
2	17-64	.265625	170	10.625
3	1-4	.25	160	10.
4	15-64	.234375	150	9.375
5	7-32	.21875	140	8.75
6	13-64	.203125	130	8.125
7	3-16	.1875	120	7.5
8	11-64	.171875	110	6.875
9	5-32	.15625	100	6.25
10	9-64	.140625	90	5.625
11	1-8	.125	80	5.
12	7-64	.109375	70	4.375
13	3-32	.09375	60	3.75
14	5-64	.078125	50	3.125
15	9-128	.0703125	45	2.8125
16	1-16	.0625	40	2.5
17	9-160	.05625	36	2.25
18	1-20	.05	32	2.
19	7-160	.04375	28	1.75
20	3-80	.0375	24	1.50
21	11-320	.034375	22	1.375
22	1-32	.03125	20	1.25
23	9-320	.028125	18	1.125
24	1-40	.025	16	1.
25	7-320	.021875	14	.875
26	3-160	.01875	12	.75
27	11-640	.0171875	11	.6875
28	1-64	.015625	10	.625
29	9-640	.0140625	9	.5625
30	1-80	.0125	8	.5
31	7-640	.0109375	7	.4375
32	13-1280	.01015625	6½	.40625
33	3-320	.009375	6	.375
34	11-1280	.00859375	5½	.34375
35	5-640	.0078125	5	.3125
36	9-1280	.00703125	4½	.28125
37	17-2560	.006640625	4¼	.265625
38	1-160	.00625	4	.25

And on and after July first, eighteen hundred and ninety-three, the same and no other shall be used in determining duties and taxes levied by the United States of America, on sheet and plate iron and steel. But this act shall not be construed to increase duties upon any articles which may be imported.

SEC. 2. That the Secretary of the Treasury is authorized and required to prepare suitable standards in accordance herewith.

SEC. 3. That in the practical use and application of the standard gauge hereby established a *variation of two and one-half per cent. either way may be allowed.*

RISDON IRON WORKS SAN FRANCISCO

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AMERICAN WIRE GAUGE.

Gauge Num.	Size Inches.	Rolled Plates. Weight per square foot.				Drawn Wire. Weight per 1000 feet.			
No.	In.	Iron. Lbs.	Steel. Lbs.	Copper. Lbs.	Brass. Lbs.	Iron. Lbs.	Steel. Lbs.	Copper Lbs.	Brass. Lbs.
0000	.4600	18.75	18.97	21.36	20.84	566.3	571.7	646.8	634.1
000	.4096	16.70	16.90	19.01	18.56	449.1	453.3	512.9	502.9
00	.3648	14.87	15.05	16.93	16.52	356.1	359.5	406.8	398.8
0	.3249	13.24	13.40	15.08	14.72	282.4	285.1	322.5	316.3
1	.2893	11.79	11.93	13.43	13.11	224.5	226.1	255.8	250.8
2	.2576	10.50	10.63	11.96	11.67	177.6	179.3	202.9	998.9
3	.2294	9.354	9.464	10.65	10.39	140.8	142.2	160.8	157.8
4	.2043	8.330	8.428	9.486	9.255	111.7	112.7	127.5	125.1
5	.1819	7.418	7.505	8.448	8.242	88.59	89.43	101.2	99.20
6	.1620	6.606	6.683	7.523	7.340	70.26	70.92	80.25	78.67
7	.1443	5.882	5.952	6.699	6.536	55.71	56.24	63.64	62.38
8	.1285	5.238	5.300	5.966	5.821	44.18	44.60	50.46	49.48
9	.1144	4.665	4.720	5.313	5.184	35.04	35.37	40.02	39.24
10	.1019	4.154	4.203	4.731	4.616	28.26	28.05	31.73	31.11
11	.0907	3.700	3.743	4.213	4.110	22.03	22.24	25.16	24.68
12	.0808	3.294	3.333	3.752	3.661	17.47	17.64	19.95	19.57
13	.0720	2.934	2.968	3.341	3.260	13.85	13.99	15.82	15.52
14	.0461	2.613	2.643	2.978	2.903	10.99	11.09	12.55	12.31
15	.0571	2.327	2.354	2.650	2.585	8.717	8.899	9.953	9.761
16	.0508	2.072	2.096	2.359	2.302	6.913	6.978	7.896	7.741
17	.0452	1.845	1.867	2.101	2.050	5.481	5.532	6.261	6.137
18	.0403	1.643	1.662	1.872	1.826	4.347	4.387	4.965	4.867
19	.0359	1.463	1.480	1.666	1.626	3.447	3.479	3.937	3.861
20	.0320	1.303	1.318	1.484	1.448	2.735	2.761	3.125	3.064
21	.0285	1.160	1.174	1.321	1.289	2.168	2.188	2.476	2.428
22	.0253	1.033	1.045	1.176	1.148	1.720	1.736	1.964	1.926
23	.0226	.9203	.9310	1.048	1.023	1.363	1.376	1.557	1.527
24	.0201	.8195	.8291	.9334	.9105	1.081	1.091	1.235	1.211
25	.0179	.7298	.7383	.8311	.8109	.8575	.8656	.9795	.9603
26	.0159	.6499	.6575	.7401	.7221	.6801	.6864	.7768	.7616
27	.0142	.5787	.5855	.6591	.6430	.5393	.5444	.6160	.6039
28	.0126	.5154	.5214	.5869	.5726	.4277	.4317	.4885	.4789
29	.0113	.4580	.4643	.5227	.5099	.3391	.3422	.3873	.3797
30	.0100	.4087	.4135	.4654	.4541	.3699	.2714	.3072	.3012
31	.0089	.3640	.3683	.4145	.4044	.2134	.2153	.2437	.2389
32	.0080	.3241	.3279	.3691	.3601	.1691	.1707	.1932	.1894
33	.0071	.2887	.2920	.3287	.3207	.1341	.1354	.1532	.1502
34	.0063	.2570	.2600	.2927	.2856	.1063	.1073	.1216	.1192
35	.0056	.2289	.2316	.2606	.2543	.0845	.0853	.0965	.0947
36	.0050	.2039	.2062	.2322	.2265	.0669	.0675	.0764	.0750
37	.0045	.1816	.1837	.2067	.2017	0531	.0536	.0606	.0594
38	.0040	.1617	.1636	.1841	.1896	.0118	.0424	.0480	.0471
39	.0035	.1440	.1456	.1640	.1600	.0334	.0337	.0381	.0374
40	.0031	.1282	.1297	.1460	.1424	.0268	.0267	.0302	.0297
Spec. grav.		7.828	7.92	8.917	8.70	7.85	7.93	8.96	8.78

The American Wire Gauge is introduced and manufactured by J. R. Brown & Sharpe, of Providence, R. I., and is to be had in the principal hardware stores in the country. It is adopted by most manufacturers of plates and wire, and is now considered the American Standard Gauge.

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BIRMINGHAM GAUGE

FOR WIRE, SHEET IRON AND STEEL.

Thickness by the Gauge.	Thickness in Inches.	Weight per Square Foot in Pounds.				Thickness in Inches.
		Sheet and Boiler Iron.	Sheet Cast Steel.	Sheet Copper.	Sheet Lead.	
No. 0000	0.454	18.267	18.259	20.566	26.75	7.16
000	0.425	17.053	17.280	19.252	25.06	27.64
00	0.380	15.247	15.451	17.214	22.42	3.8
0	0.340	13.7	14.0	15.6	20.06	11.32
1	0.300	12.1	12.4	13.8	17.72	5.16
2	0.284	11.4	11.7	13.0	16.75	9.32
3	0.259	10.4	10.6	11.9	15.26	1.4
4	0.238	9.60	9.80	11.0	14.02	7.32
5	0.220	8.85	9.02	10.1	12.98	7.32
6	0.203	8.17	8.33	9.32	11.98	7.32
7	0.180	7.24	7.38	8.25	10.63	3.16
8	0.165	6.65	6.78	7.59	9.73	3.16
9	0.148	5.96	6.08	6.80	8.72	5.32
10	0.134	5.40	5.51	6.16	7.90	5.32
11	0.120	4.83	4.93	5.51	7.08	1.8
12	0.109	4.40	4.50	5.02	6.42	1.8
13	0.095	3.83	3.91	4.37	5.60	3.32
14	0.083	3.34	3.41	3.81	4.90	3.32
15	0.072	2.90	2.96	3.31	4.25	1.16
16	0.065	2.62	2.67	3 00	3.83	1.16
17	0.058	2.34	2.39	2.67	3.42	1.16
18	0.049	1.97	2.01	2.25	2.90	1.16
19	0.042	1.69	1.72	1.93	2.48	3.64
20	0.035	1.41	1.42	1.61	2.04	3.64
21	0.032	1.29	1.31	1.47	1 89	3.64
22	0.028	1.13	1.15	1.29	1.65	1.32
23	0.025	1.00	1.02	1.14	1.47	1.32
24	0.022	0.885	0.903	1.01	1.30	1.32
25	0.020	0.805	0.820	0.918	1.18	1.32
26	0.018	0.724	0.738	0.826	1.06	1.64
27	0.016	0.644	0.657	0.735	0.945	1.64
28	0.014	0.563	0.574	0.642	0.826	
29	0.013	0.523	0.533	0.597	0.767	
30	0.012	0.483	0.493	0.551	0.708	
31	0.010	0.402	0.410	0.480	0.600	
32	0.009	0.362	0.370	0.420	0.532	
33	0.008	0.322	0.328	0.370	0.472	
34	0.007	0.282	0.288	0.323	0.413	
35	0.005	0.230	0.235	0.262	0.309	
36	0.004	0.170	0.173	0.194	0.236	

BIRMINGHAM GAUGE FOR SILVER AND GOLD.

No.	Thick. Inch	No.	Thick. Inch.	No.	Thick. Inch.	No.	Thick. Inch.	No.	Thick. Inch.	No.	Thick. Inch.
1	.004	7	.015	13	.036	19	.064	25	.095	31	.133
2	.005	8	.016	14	.041	20	.067	26	.103	32	.143
3	.008	9	.019	15	.047	21	.072	27	.131	33	.145
4	.010	10	.024	16	.051	22	.074	28	.120	34	.148
5	.013	11	.029	17	.057	23	.877	29	.120	35	.158
6	.013	12	.034	18	.061	24	.082	30	.126	36	.167

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TABLE

Containing the Circumference and Areas of Circles, from one-sixteenth to one hundred, advancing by sixteenths.

Diam.	Circumference.	Area.	Diam.	Circumference.	Area.	Diam.	Circumference.	Area.
1-16	.1963	.0030	4	12.5664	12.5664	8	25.1328	50.2656
1-8	.3927	.0122	1-16	12.7627	12.9622	1-16	25.3291	51.0541
3-16	.5890	.0276	1-8	12.9591	13.3640	1-8	25.5255	51.8486
1-4	.7854	.0490	3-16	13.1554	13.7721	3-16	25.7218	52.8994
5-16	.9817	.0767	1-4	13.3518	14.1862	1-4	25.9182	53.4562
3-8	1.1781	.1104	5-16	13.5481	14.6066	5-16	26.1145	54.2748
7-16	1.3744	.1503	3-8	13.7445	15.0331	3-8	26.3109	55.0885
1-2	1.5708	.1963	7-16	13.9408	15.4657	7-16	26.5072	55.9138
9-16	1.7671	.2485	1-2	14.1372	15.9043	1-2	26.7036	56.7451
5-8	1.9635	.3068	9-16	14.3335	16.3492	9-16	26.8999	57.5887
11-16	2.1598	.3712	5-8	14.5298	16.8001	5-8	27.0963	58.4264
3-4	2.3562	.4417	11-16	14.7262	17.2573	11-16	27.2926	59.7762
13-16	2.5525	.5185	3-4	14.9226	17.7205	3-4	27.4890	60.1321
7-8	2.7489	.6013	13-16	15 1189	18.1900	13-16	27.6853	60.9943
15-16	2.9452	.6903	7-8	15.3153	18.6655	7-8	27.8817	61.8625
			15-16	15.5716	19.1472	15-16	28.0780	62.7369
1	3.1416	.7854						
1-16	3 3379	.8861	5	15.7080	19.6350	9	28.2744	63.6174
1-8	3.5343	.9940	1-16	15.9043	20.1290	1-16	28.4707	64.5041
3-16	3.7306	1.1075	1-8	16.1007	20.6290	1-8	28.6671	65.3968
1-4	3.9270	1.2271	3-16	16.2970	21.1252	3-16	28.8634	66.2957
5-16	4.1233	1.3529	1-4	16.4934	21.6475	1-4	29.0598	67.2007
3-8	4.3197	1.4848	5-16	16.6897	22.1661	5-16	29.2561	68.1120
7-16	4.5160	1.6229	3-8	16.8861	22.6907	3-8	29.4525	69.0293
1-2	4.7124	1.7671	7-16	17.0824	23.2215	7-16	29.6488	69.9528
9-16	4.9087	1.9175	1-2	17.2788	23.7583	1-2	29.8452	70.8823
5-8	5.1051	2.0739	9-16	17.4751	24.3014	9-16	30.0415	71.8181
11-16	5.3014	2.2365	5-8	17.6715	24.8505	5-8	30.2379	72.7599
3-4	5.4978	2.4052	11-16	17.8678	25.4058	11-16	30.4342	73.7079
13-16	5.6941	2.5801	3-4	18.0642	25.9672	3-4	30.6306	74.6620
7-8	5.8905	2.7611	13-16	18.2605	26.5348	13-16	30.8269	75.6223
15-16	6.0868	2.9483	7-8	18.4569	27.1085	7-8	31.0233	76.5887
			15-16	18.6532	27.6884	15-16	31.2196	77.5613
2	6.2832	3.1416	6	18.8496	28.2744	10	31.4160	78.5400
1-16	6.4795	3.3411	1-16	19.0459	28.8665	1-16	31.6123	79.5248
1-8	6.6759	3.5465	1-8	19.2423	29.4647	1-8	31.8087	80.5157
3-16	6.8722	3.7582	3-16	19.4386	30.0798	3-16	32.0050	81.5128
1-4	7.0686	3.9760	1-4	19.6350	30.6796	1-4	32.2014	82.5160
5-16	7.2649	4.2001	5-16	19.8313	31.2964	5-16	32.3977	83.5254
3-8	7.4613	4.4302	3-8	20.0277	31.9192	3-8	32.5941	84.5409
7-16	7.6576	4.6664	7-16	20.2240	32.5481	7-16	32.7904	85.5626
1-2	7.8540	4.9087	1-2	20.4204	33.1831	1-2	32.9868	86.5903
9-16	8.0503	5.1573	9-16	20.6167	33.8244	9-16	33.1831	87 6243
5-8	8.2467	5.4119	5-8	20.8131	34.4717	5-8	33.3795	88.6643
11-16	8.4430	5.6727	11-16	21.0094	35.1252	11-16	33.5758	89.7105
3-4	8.6394	5.9395	3-4	21.2058	35.7847	3-4	33.7722	90.7627
13-16	8.8357	6.2126	13-16	21.4021	36.4505	13-16	33.9685	91.8212
7-8	9.0321	6.4918	7-8	21.5985	37.1224	7-8	34.1649	92.8858
15-16	9.2284	6.7772	15-16	21.7948	37.8005	15-16	34.3612	93.9566
3	9.4248	7.0686	7	21.9912	38.4846	11	34.5576	95.0334
1-16	9.6211	7.3662	1-16	22.1875	39.1749	1-16	34.7539	96.1164
1-8	9.8175	7.6699	1-8	22.3839	39.8713	1-8	34.9503	97.2053
3-16	10.0138	7.9798	3-16	22.5802	40.5469	3-16	35.1466	98.3008
1-4	10.2102	8.2957	1-4	22.7766	41.2825	1-4	35.3430	99.4021
5-16	10.4065	8.6179	5-16	22.9729	41.9974	5-16	35.5393	100.5097
3-8	10.6029	8.9462	3-8	23.1693	42.7184	3-8	35.7357	101.6234
7-16	10.7992	9.2806	7-16	23.3656	43.4455	7-16	35.9320	102.7432
1-2	10.9956	9.6211	1-2	23.5620	44.1787	1-2	36.1284	103.8691
9-16	11.1919	9.9678	9-16	23.7583	44.9181	9-16	36.3247	105.0012
5-8	11.3883	10.3206	5-8	23.9547	45.6636	5-8	36.5211	106.1394
11-16	11.5846	10.6796	11-16	24.1510	46.4153	11-16	36.7174	107.2838
3-4	11.7810	11.0446	3-4	24.3474	47.1730	3-4	36.9138	108.4342
13-16	11.9773	11.4159	13-16	24.5437	47 9370	13-16	37.1101	109.5909
7-8	12.1737	11.7932	7-8	24.7401	48.7070	7.8	37.3065	110.7536
15-16	12.3700	12.1768	15-16	24.9364	49.4833	15-16	37.5028	111.9226

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TABLE OF CIRCLES—CONTINUED.

Diam.	Circumference.	Area.	Diam.	Circumference.	Area.	Diam.	Circumference.	Area.
12	37.6992	113.0976	16 3-8	51.4437	210.5976	20 3-4	65.1882	338.1637
1-16	37.8965	114.2788	7-16	51.6400	212 2083	13-16	65.3845	340.2040
1-8	38.0919	115.4660	1-2	51.8364	213.8251	7-8	65.5809	342.2503
3-16	38.2882	116.6645	9-16	52.0327	215.4481	15-16	65.7772	344.3028
1-4	38.4846	117.8590	5-8	52.2291	217.0772			
5-16	38.6809	119.0648	11-16	52.4254	218.7124	21	65.7936	346.3614
3-8	38.8773	120.2766	3-4	52.6218	220.3537	1-16	66.1669	348.4267
7-16	39.0736	121.4946	13-16	52.8181	222.0013	1.8	66.3663	350.4970
1-2	39.2700	122.7187	7-8	53.0145	223.6549	3-16	66.5626	352.5740
9-16	39.4663	123.9490	15-16	53.2108	225.3147	1-4	66.7590	354.6571
5-8	39.6627	125.1854				5-16	66.9553	356.7465
11-16	39.8590	126.4479	17	53.4072	226.9806	3-8	67.1517	358.8419
3-4	40.0554	127.6765	1-16	53.6035	228.6527	7-16	67.3480	360.9435
13-16	40.2517	128.8999	1-8	53.7999	230.3308	1-2	67.5444	363.0511
7-8	40.4481	130 1923	3-16	53.9962	232.0151	9-16	67.7407	365.1650
15.16	40.6444	131.4279	1-4	54.1926	233.7055	5-8	67.9371	367.2849
			5-16	54.3889	235.4022	11-16	68.1334	369.4110
13	40.8408	132.7326	3-8	54.5853	237.1049	3-4	68.3298	371.5432
1-16	41.0371	134.0120	7-16	54.7816	238.8138	13-16	68.5261	373.6816
1-8	41.2338	135.2974	1-2	54.9780	240.5287	7-8	68.7225	375.8261
3-16	41.4298	136.5890	9-16	55.1743	242.2499	15-16	68.9188	377.9768
1-4	41.6262	137.8867	5-8	55.3707	243.9771			
5-16	41.8225	139.1907	11-16	55.5670	245.7105	22	69.1152	380.1336
3-8	42.0189	140.5007	3-4	55.7634	247.4500	1-16	69.3115	382.2965
7-16	42 2152	141.8169	13-16	55.9597	249.1952	1-8	69.5079	384.4655
1-2	42.4116	143.1391	7-8	56.1561	250.9475	3-16	69.7042	386.6907
9-16	42.6079	144.4726	15-16	56.3524	252.7050	1-4	69.9006	388.8220
5-8	42.8043	145.8021				5-16	70.0969	391.0095
11-16	43.0006	147.1428	18	56.5488	254.4696	3-8	70.2933	393.2031
3-4	43.1970	148.4896	1-16	56.7451	256.2398	7-16	70.4806	395.4029
13-16	43.3933	149.8426	1-8	56.9415	258.0161	1-2	70.6860	397.6087
7-8	43.5897	151.2017	3-16	57.1378	259.7986	9-16	70.8823	399.8207
15-16	43.7860	152.5670	1-4	57.3342	261.5872	5-8	71.0787	402.0388
			5-16	57.5305	263.3820	11-16	71.2750	404.2631
14	43.9824	153.9384	3-8	57.7269	265.1829	3-4	71.4714	406.4935
1-16	44.1787	155.3159	7-16	57.9282	266.9900	13-16	71.6677	408.7301
1-8	44.3751	156.6995	1-2	58.1196	268.8031	7-8	71.8641	410.9728
3-16	44.5714	158.0893	9-16	58.2159	270.6225	15-16	72 0604	413.2317
1-4	44.7676	159.4852	5-8	58.5123	272.4479			
5-16	44.9641	160.8374	11-16	58.7806	274.2895	23	72.2568	415.4766
3-8	45.1605	162.2956	3-4	58.9056	276.1171	1-16	72.4531	417.7377
7-16	45.3568	163.7099	13-16	59.1013	277.9610	1-8	72.6495	420.0049
1-2	45.5532	165.1303	7-8	59.2977	279.8110	3-16	72.8458	422.2783
9-16	45.7495	166.5569	15-16	59.4940	281.1672	1-4	73.0422	424.5577
5-8	45.9459	167.9896				5-16	73.2385	426.3434
11-16	46.1422	169.4285	19	59.6904	283.5294	3-8	73.4349	429.1352
3-4	46.3386	170.8735	1-16	59.8867	285.3978	7.16	73.6312	431.4331
13-16	46.5349	172.3247	1-8	60.0831	287.2723	1-2	73.8276	433.7371
7-8	46.7313	173.7820	3-16	60.2794	289.4030	9-16	74.0239	436.0473
15-16	46.9276	175.2455	1-4	60.4708	291.0397	5-8	74.2203	438.3636
			5-16	60.6721	292.9324	11-16	74.4166	440.6811
15	47.1240	176.7150	3-8	60.8685	294.8312	3-4	74.6130	443.0146
1-16	47.3203	178.1907	7-16	61.0648	296.7367	13-16	74.8093	445.3539
1-8	47.5167	179.6725	1-2	61.2612	298.6483	7-8	75.0057	447.6992
3-16	47.7130	181.1105	9-16	61.4575	300.5658	15-16	75.2020	450.0418
1-4	47.9094	182.6545	5-8	61.6539	302.4894			
5-16	48.1057	184.1548	11-16	61.8502	304.4192	24	75.3984	452.3904
3-8	48.3021	185.6612	3-4	62.0466	306.3550	1-16	75.5947	454.7497
7-16	48.4984	187.1737	13-16	62.2429	308.2971	1-8	75.7911	457.1150
1-2	48.6948	188.6923	7-8	62.4393	310.2452	3-16	75.9874	459.4866
9 16	48.8911	190.2171	15-16	62.6356	312.1996	1-4	76.1838	461.8642
5 8	49.0875	191.7480				5-16	76.3801	464.2481
11-16	49.2838	193.3351	20	62.8320	314.1600	3-8	76.5765	466.6380
3-4	49.4802	194.8282	1-16	63.0283	316.1266	7-16	76.7728	469.0341
13-16	49.6765	196.3776	1-8	63.2247	318.0992	1-2	76.9692	471.4363
7-8	49.8729	197.9330	3-16	63.4210	320.0781	9-16	77.1655	473.8447
15-16	50.0692	199.4947	1-4	63.6174	322.0630	5-8	77.3619	476.2592
			5-16	63.8137	324.0542	11-16	77.5582	478.6798
16	50.2656	201.0624	3-8	64.0101	326.0514	3-4	77.7546	481.1065
1-16	50.4619	202.6363	7-16	64.2064	328.0548	13-16	77.9509	483.5395
1-8	50.6583	204.2162	1-2	64.4028	330.0643	7-8	78.1473	485.9785
3-16	50.8546	205.8024	9-16	64.5991	332.0800	15-16	78.3436	488.4237
1-4	51.0510	207.3946	5-8	64.7955	334.1018			
5-16	51.2473	208.9931	11-16	64.9918	336.1297			

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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TABLE OF CIRCLES—CONTINUED.

Diam.	Circumference.	Area.	Diam.	Circumference.	Area.	Diam.	Circumference.	Area.
25	78.5400	490.8750	29 3-8	92.2845	677.7143	33 3-4	106.0290	894.6196
1-16	78.7363	493.3325	7-16	92.4808	680.6013	13-16	106.2253	897.9360
1-8	78.9327	495.7960	1-2	92.6772	683.4943	7-8	106.4217	901.2587
3-16	79.1290	498.2657	9-16	92.8735	686.3936	15-16	106.6180	904.5875
1-4	79.3254	500.7415	5-8	93.0699	689.2989			
5-16	79.5217	503.2236	11-16	93.2662	692.2104			
3-8	79.7181	505.7117	3-4	93.4626	695.1280	34	106.8144	907.9224
7-16	79.9144	508.2060	13-16	93.6589	698.0518	1-16	107.0107	911.2645
1-2	80.1108	510.7063	7-8	93.8553	700.9817	1-8	107.2071	914.6105
9-16	80.3071	513.2129	15-16	94.0516	703.9178	3-16	107.4034	917.9640
5-8	80.5035	515.7255				1-4	107.5998	921.3232
11-16	80.6998	518.2443	30	94.2480	706.8600	5-16	107.7961	924.6883
3-4	80.8962	520.7692	1-16	94.4443	709.8083	3-8	107.9925	928.0605
13-16	81.0925	523.3003	1-8	94.6407	712.7627	7-16	108.1888	931.4380
7-8	81.2889	525.8375	3-16	94.8370	715.7233	1-2	108.3852	934.8223
15-16	81.4852	528 3009	1-4	95.0334	718.6900	9-16	108.5815	938.2121
			5-16	95.2297	721.6629	5-8	108.7779	941.6087
26	81.6816	530.9304	3-8	95.4261	724.6419	11-16	108.9742	945.0110
1-16	81.8779	533.4860	7-16	95.6224	727.6271	3-4	109.1706	948.4195
1-8	82.0743	536.0477	1-2	95.8188	730.6183	13-16	109.3669	951.8341
3-16	82.2706	538.6156	9-16	96.0151	733.6158	7-8	109.5633	955.2550
1-4	82.4670	541.1896	5-8	96.2115	736.6193	15-16	109.7596	958.6820
5-16	82.6633	543.7698	11-16	96.4078	739.6290			
3-8	82 8597	546.3561	3-4	96.6042	742.6447	35	109.9560	962.1150
7-16	83.0560	548.9486	13-16	96.8005	745.6667	1-16	110.1523	965.5542
1-2	83.2524	551.5471	7-8	96.9969	748.6948	1 8	110.3487	968.9995
9-16	83.4487	554.1519	15-16	97.1932	751.7291	3-16	110.5450	972.4510
5-8	83.6451	556.7627				1-4	110.7414	975.9065
11-16	83.8414	559.3797	31	97.3896	754.7694	5-16	110.9377	979.3686
3-4	84.0378	562.0027	1-16	97.5859	757.8159	3-8	111.1341	982.8422
13-16	84.2341	564.6320	1-8	97.7823	760.8685	7-16	111.3304	986.3180
7-8	84.4305	567.2674	3-16	97.9786	763.9273	1-2	111.5268	989.8003
15-16	84.6268	569.4090	1-4	98.1750	766.9921	9-16	111.7231	993.2097
			5-16	98.3713	770.0632	5-8	111.9195	996.7830
27	84.8232	572.5566	3-8	98.5677	773.1404	11-16	112.1158	1000.3472
1-16	85.0195	575.2104	7-16	98.7648	776.2237	3-4	112.3122	1003.7902
1-8	85.2159	577.8703	1-2	98.9684	779.3131	13-16	112.5086	1007.3030
3-16	85.4122	580.5364	9-16	99.1567	782.4087	7-8	112.7049	1010.8220
1-4	85.6086	583.2085	5-8	99.3531	785.5104	15-16	112.9012	1014.3472
5-16	85.8049	585.8869	11-16	99.5494	788.6183			
3-8	86.0013	588.5714	3-4	99.7458	791.7322	36	113.0976	1017.8784
7-16	86.1976	591.2620	13-16	99.9421	794.8524	1-16	113.2939	1021.4158
1-2	86.3940	593.9587	7-8	100.1385	797.9786	1-8	113.4903	1024.9592
9-16	86.5903	596.6616	15-16	100.3348	801.1111	3-16	113.6866	1028.5089
5-8	86.7867	599.3706				1-4	113.8830	1032.0646
11-16	86.9830	602.0858	32	100.5312	804.2496	5-16	114.0793	1035.6266
3-4	87.1794	604.8070	1-16	100.7275	807.3943	3-8	114.2757	1039.1946
13-16	87.3757	607.5345	1-8	100.9240	810.5450	7-16	114.4720	1042.7913
7-8	87.5721	610.2680	3-16	101.1202	813.7020	1-2	114.6684	1046.3941
15-16	87.7684	613.0078	1-4	101.3166	816.8650	9-16	114.8647	1049.9581
			5-16	101.5130	820.0343	5-8	115.0611	1053 5281
28	87.9648	615.7536	3-8	101.7093	823.2096	11-16	115.2572	1057.1269
1-16	88.1611	618.5051	7-16	101.9056	826.3911	3-4	115.4538	1060.7317
1-8	88.3575	621.2636	1-2	102.1020	829.5787	13-16	115.6501	1064.3428
3-16	88.5538	624.0279	9-16	102.2983	832.7725	7-8	115 8465	1067.9599
1-4	88.7502	626.7982	5-8	102.4947	835.9724	15-16	116.0428	1071.5832
5-16	88.9465	629.5748	11-16	102.6910	839.1784			
3-8	89.1429	632.3574	3-4	102.8874	842.3905			
7-16	89.3392	635.1462	13-16	103.0837	845.6089	37	116.2392	1075.2126
1-2	89.5356	637.9411	7-8	103.2801	848.8333	1-16	116.4355	1078.8482
9-16	89.7319	640.7422	15-16	103.4764	852.0639	1-8	116.6319	1082.4898
5-8	89.9283	643.5494				3-16	116.8282	1086.1376
11-16	90.1246	646.3627	33	103.6728	855.3006	1-4	117.0246	1089.7915
3-4	90.3210	649.1821	1-16	103.8691	858.5436	5-16	117.2209	1093.4517
13-16	90.5173	652.0078	1-8	104.0655	861.7924	3-8	117.4173	1097.1179
7-8	90.7137	654.8395	3-16	104.2618	865.0475	7-16	117 6136	1100.7903
15-16	90.9100	657.6774	1-4	104.4582	868.3087	1-2	117.8100	1104.4687
			5-16	104.6545	871.5760	9-16	118.0063	1108.1534
29	91.1064	660.5214	3-8	104.8509	874.8497	5-8	118.2027	1111.8441
1-16	91.3027	663.3716	7-16	105.0472	878.1290	11-16	118.3990	1115.5410
1-8	91.4991	666.2278	1-2	105.2436	881.4151	3-4	118.5954	1119.2440
3-16	91.6954	669.0902	9-16	105.4399	884.7070	13-16	118.7917	1122.9532
1-4	91.8918	671.9587	5-8	105.6363	888.0051	7-8	118.9881	1126.6685
5-16	92 0081	674.8335	11-16	105.8326	891.3090	15-16	119.1844	1130.3900

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TABLE OF CIRCLES—CONTINUED.

Diam.	Circumference.	Area.	Diam.	Circumference.	Area.	Diam.	Circumference.
38	119.3806	1134.1176	12 3-8	133.1253	1410.2961	46 3-4	146.8698
1-16	119.5771	1137.8513	7-16	133.3216	1414.4594	13-16	147.0661
1-8	119.7735	1141.5911	1 2	133.5180	1418.6287	7-8	147.2625
3-16	119.9698	1145.3371	9-16	133.7143	1422.8043	15-16	147.4588
1-4	120.1662	1149.0892	5-8	133.9107	1426.9859		
5-16	120.3625	1152.8475	11-16	134.1070	1431.1737	47	147.6552
3-8	120.5589	1156.6119	3-4	134.3034	1435.3675	1-16	147.8515
7-16	120.7552	1160.3825	13-16	134.4997	1439.5676	1.8	148.0479
1-2	120.9516	1164.1591	7-8	134.6961	1443.7738	3-16	148.2442
9-16	121.1479	1167.9420	15-16	134.8924	1447.9862	1-4	148.4406
5-8	121.3443	1171.7309				5-16	148.6369
11-16	121.5406	1175 5260	43	135.0888	1452.2046	3-8	148.8333
3-4	121.7370	1179.3271	1-16	135.2851	1456.4292	7-16	149.0296
13-16	121.9333	1183.1345	1-8	135.4815	1460.6599	1-2	149.2260
7-8	122.1297	1186.9480	3-16	135.6778	1464.8968	9-16	149.4223
15-16	122.3260	1190.7677	1-4	135.8742	1469.1397	5-8	149.6187
			5-16	136.0705	1473.3889	11-16	149.8150
39	122.5224	1194.5934	3-8	136.2669	1477.6342	3-4	150.0114
1-16	122.7187	1198.4253	7-16	136.4632	1481.9006	13-16	150.2077
1-8	122.9151	1202.2633	1-2	136.6596	1486.1731	7-8	150.4041
3-16	123.1114	1206.1075	9-16	136.8559	1490.4468	15-16	150.6004
1-4	123.3078	1209.9577	5-8	137.0523	1494.7266		
5-16	123.5041	1213.8142	11-16	137.2486	1499.0126		
3-8	123.7005	1217.6768	3-4	137.4450	1503.3046	48	150.7968
7-16	123.8968	1221.5455	13-16	137.6413	1507.6029	1-16	150.9931
1-2	124.0932	1225.4203	7-8	137.8377	1511.9072	1-8	151.1895
9-16	124.2895	1229.3013	15-16	138 0340	1516.2178	3-16	151.3858
5-8	124.4859	1233.1884				1-4	151.5822
11-16	124.6822	1237.0817	44	138.2304	1520.5344	5-16	151.7785
3-4	124.8786	1240.9810	1-16	138.4267	1524.8572	3 8	151.9749
13-16	125.0749	1244.8866	1-8	138 6231	1529.1860	7-16	152.1712
7-8	125.2713	1248.7982	3-16	138.8194	1533.5211	1-2	152.3676
15-16	125.4676	1252.7161	1-4	139.0158	1537.8622	9-16	152.5639
			5-16	139.2121	1542.2046	5 8	152.7603
40	125.6640	1256.6400	3-8	139.4085	1546.5530	11-16	152.9566
1-16	125.8603	1260.5701	7-16	139.6048	1550 9176	3-4	153.1530
1-8	126.0567	1264.5062	1-2	139.8012	1555.2883	13-16	153.3493
3-16	126.2530	1268.4486	9-16	139.9975	1559.6602	7-8	153.5457
1-4	126.4494	1272.3970	5-8	140.1939	1564.0382	15-16	153.7420
5-16	126.6457	1276.3517	11-16	140.3902	1568.4223		
3-8	126.8421	1280.3124	3-4	140.5866	1572.8125	49	153.9384
7-16	127.0384	1284.2793	13-16	140.7829	1577.2090	1-16	154.1347
1-2	127.2348	1288.2523	7-8	140.9793	1581.6115	1-8	154.3311
9-16	127.4311	1292.2315	15-16	141.1756	1586.0203	3-16	154.5274
5-8	127.6275	1296.2168				1-4	154.7238
11-16	127.8238	1300.2082	45	141.3720	1590.4350	5-16	154.9201
3-4	128 0202	1304.2057	1-16	141.5683	1594.4560	3 8	155.1165
13-16	128.2165	1308.2095	1-8	141.7647	1599.2830	7-16	155.3128
7-8	128.4129	1312.2193	3-16	141.9610	1603.7162	1-2	155.5092
15-16	128.6092	1316.2353	1-4	142.1574	1608.1555	9-16	155.7055
			5-16	142.3537	1612.5961	5-8	155.9019
41	128.8056	1320.2574	3-8	142.5501	1617.0427	11-16	156.0982
1-16	129.0019	1324.2857	7-16	142.7464	1621.5055	3-4	156.2946
1-8	129.1983	1328.3200	1-2	142.9428	1625.9743	13-16	156.4909
3-16	129.3946	1332.3605	9-16	143.1391	1630.4444	7-8	156.6873
1-4	129.5910	1336.4071	5-8	143.3355	1634.9205	15-16	156.8836
5-16	129.7873	1340.4600	11-16	143.5318	1639.4028		
3-8	129.9837	1344.5189	3-4	143.7282	1643.8912		
7-16	130.1800	1348.5840	13-16	143.9245	1648.3858	50	157.0800
1-2	130.3764	1352.6551	7-8	144.1209	1652.8865	1-16	157.2763
9-16	130 5727	1356.7325	15-16	144.3172	1657.3934	1-8	157.4727
5 8	130.7691	1360.8159				3-16	157.6690
11-16	130.9654	1364.9055	46	144.5136	1661.9064	1-4	157.8654
3-4	131.1618	1369.0012	1-16	144.7099	1666.4255	5-16	158.0617
13-16	131.3581	1373.1031	1-8	144.9063	1670.9507	3-8	158.2581
7-8	131.5545	1377.2111	3-16	145.1026	1675.4821	7-16	158.4544
15 16	131.7508	1381.3253	1-4	145.2990	1680.0196	1-2	158.6508
			5-16	145.4953	1684.5583	9-16	158.8471
42	131.9472	1385.4456	3-8	145.6917	1689.1031	5-8	159.0435
1-16	132.1435	1389.5720	7-16	145.8880	1693.6641	11-16	159.2398
1-8	132.3399	1393.7075	1-2	146.0844	1698.2311	3-4	159.4362
3-16	132.5362	1397.8432	9-16	146.2807	1702.7994	13-16	159.6325
1-4	132.7326	1401.9880	5-8	146.4771	1707.3737	7-8	159.8289
5-16	132.9289	1406.1390	11-16	146.6734	1711.9542	15-16	160.0252

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRAN(

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USEFUL NOTES.

Where the word HEAD is used in connection with water, it means the vertical distance in feet between any given point at which the head is required and the surface of the water at its highest level.

1 cubic foot of distilled water (U. S. Standard) barometer 30 inches, 39.83° Fahr.=62.3793 pounds, generally figured 62.5 pounds.

1 cubic foot of distilled water (U. S. Standard,) 7.48052 gallons, generally figured 7.5 gallons.

1 gallon (U. S. Standard) 231 cubic inches=0.133681 cubic feet=8.3389 pounds of water, generally figured 8⅓ pounds of water.

To find the pressure in pounds per square inch of a column of water, multiply the height of the column in feet by .434.

Doubling the diameter of a pipe increases its capacity four times.

27,154 gallons of water will spread 1 in. deep over an acre of ground.

A column of water 2.31 feet high gives a pressure of 1 lb. per square inch on its base.

A *foot-pound* of work is the work expended in raising one pound one foot high in one minute.

A *horse-power* is 33,000 pounds raised one foot high in one minute, or 33,000 foot-pounds.

To find the theoretical horse-power required to raise water a given height, multiply the number of pounds of water to be raised per min. by the height in feet from level of suction water to level of discharge and divide by 33,000.

The actual horse-power required will be nearly double that found by preceding rule, because of the friction absorbed by the pumping machinery and by the water in the pipes.

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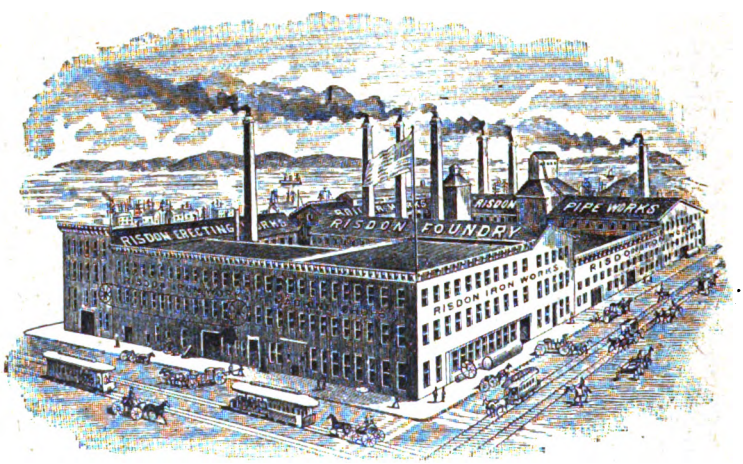
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CATALOGUE No. 7

Air Compressing Machinery

AND

IMPROVED ROCK DRILLS

BUILDERS OF

Risdon Water Wheels "Pelton Type"
Improved Bryan Roller Mills
Evans Hydraulic Elevators and
Hydraulic Mining Machinery
Ore Feeders, Rock Breakers
Mining, Pumping and Hoisting Plants
Knight's Water Wheels

PUBLISHED BY

The Risdon Iron Works

SAN FRANCISCO, CAL.

1897

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SHIPMENTS

Give full shipping directions with order. State whether preference is to be given to a certain route, and, if so, give the name of railroad, etc.

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SAN FRANCISCO, CAL.

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Hydraulic Riveted Sheet Steel and Iron Pipe a Specialty

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DONE IN SAN FRANCISCO AT PRINTING SHOP OF THE E. D. TAYLOR COMPANY, IN THE MONTH OF JANUARY AND YEAR EIGHTEEN HUNDRED AND NINETY-EIGHT.

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PREFACE.

The use and application of compressed air dates back more than a century. but it has been only within the last few years that its greatest value as a power transmitter has been fully recognized.

Engineers in general have looked with indifference upon the use of compressed air as a means of power transmission, considering the method one of very low efficiency. This was due largely to the fact that no accurate and reliable data were available from which to form conclusions.

The large Compressed Air Power Plants, installed at Paris, France, and Birmingham, England, delivering and distributing power, miles from the central stations, have clearly demonstrated the economical value of the system, and have furnished a large amount of data, obtained from practical working tests, affording the most trustworthy results as to loss in pressure due to resistance in pipes, and the efficiency of the compressors and motors employed.

It is safe to say, that when power is transmitted short distances, from one to two miles, it can be accomplished by compressed air cheaper than by electricity, both as to first cost and maintenance.

For the underground work in mines, such as pumping, hoisting and drilling, compressed air is superior to all other know methods, and will hold the field against all competitors. The reasons for this are so obvious that they need not be enumerated.

Our Catalogue No. 7, on Air Compressors and Drills, we submit to the mining public, and would state that our experience in machinery of this kind is of thirty-five years building strictly first-class compressors.

Our Compound Air Cylinders are, without doubt, the most efficient two stage machine ever built.

We particularly call attention to our Ring Inlet Valve which, after ten years use, perfected up to date, we can guarantee a volumetric efficiency greater than any other.

We are prepared to submit figures on transmission of Pneumatic Power any distance.

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INTRODUCTION.

This company has had an experience of over 35 years in the manufacture of air compressors, during which time we have used and tested the different devices for the compression of air, and the several types finally selecsed and now manufactured by us may be accepted with full confidence that they embody every essential point which makes machinery of this kind good, economical and durable, not for a time only, but permanently so.

A marked peculiarity of air compressors and other machinery built by this company is simplicity and absence of complication. Such machinery can be put in the hands of ordinary engineers with every assurance that good service and economy will be maintained. The importance of this will be seen when it is remembered that compressed air can only be used with economy when it is obtained at the least cost. Other machines are soon at a disadvantage because they require close watching and constant adjustment and refitting to insure tightness of the working parts without which economy is impossible.

It is a fundamental fact in business, and especially in the air compressor business, that a product of a high class, the best in its line, does and always will command a higher price. The difference in price between the best compressor and one not so good, divided by the number of days in the fifteen or twenty years of use, amounts to but a few cents a day, and this may be regarded as cheap insurance against breakdowns and incidental delays. This difference is besides made up over and over again every day in the greater economy of fuel and maintenance.

It is plain by comparison that although Risdon Ring Inlet Air Compressors are simple in design, they are of such strength, and in material and workmanship are of such a high standard, that under equal conditions they cost more to build than to build any other air compressor. The superior quality so gained, however, returns its extra cost many times over in the lifetime of the machine.

When asking for quotations on air compressors, state the volume required per minute, mentioning whether this is *free* air or compressed air ; state the pressure required and whether a steam-driven or belt compressor is wanted. If the former, state the steam pressure carried. If the above questions cannot be answered, give full details of the work to be done and we will give you our best advice on the subject.

Remember our Inlet Valves insures a greater volumetric efficiency than any other compressor of equal area.

Our Ring Inlet Valves and Regulators are fully covered by U. S. Patents.

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Description of Risdon Ring Inlet Air Clyinders

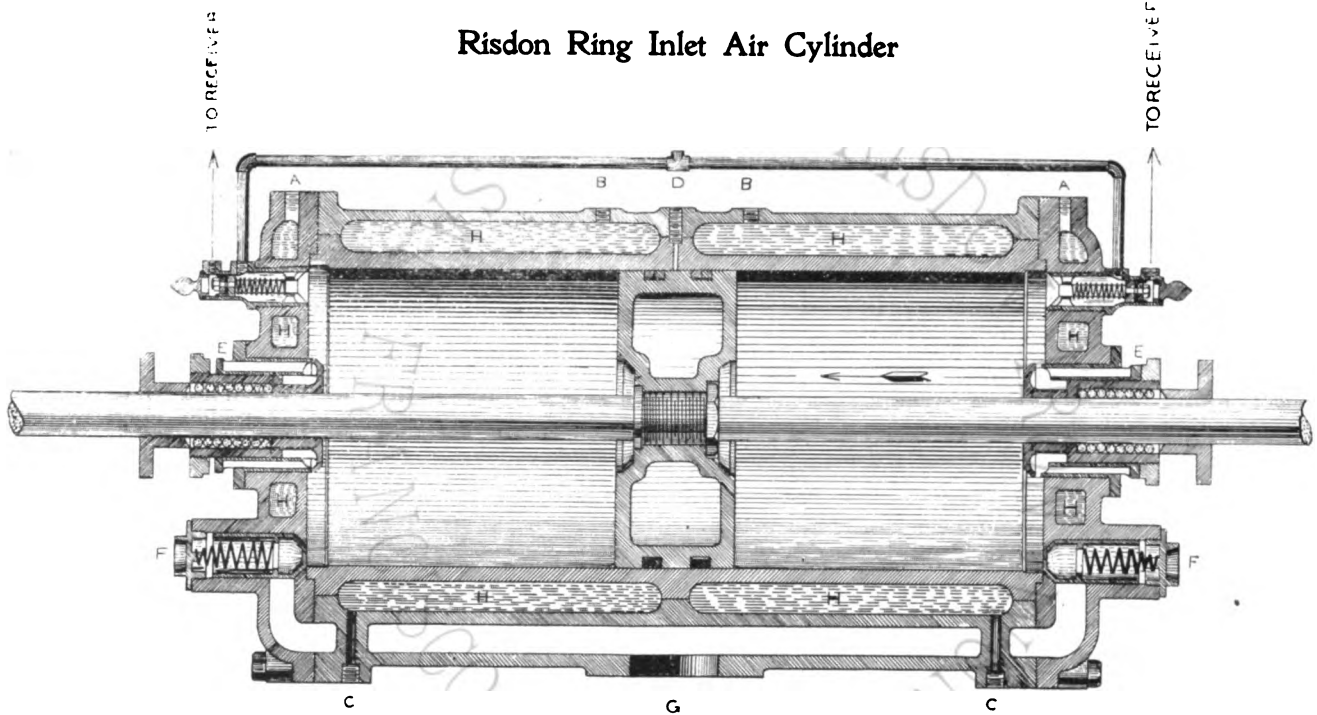
The Air Inlet Valves E, located in each head, are carried on piston and tail rod, giving positive action with the slightest movement of the machine. The cylinders are completely jacketed on walls and heads.

The walls have an independent stream of water from centre to each head. The volumetric efficiency of our Air Cylinders exceeds that of any other make.

Our regulators govern all kinds of motive power.

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Risdon Ring Inlet Air Cylinder



DETAILS OF AIR CYLINDER

A—CIRCULATING WATER INLET
B—CIRCULATING WATER OUTLET
C—WATER JACKET DRAIN PIPE
D—OIL HOLE FOR AUTOMATIC OIL CUP
E—AIR INLET VALVES
F—AIR DISCHARGE VALVES
G—AIR DISCHARGE
H—WATER JACKET
I—RELIEF VALVES

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Risdon Compressor Regulator or Unloading Device

This regulator is for the purpose of taking load off engine when the pressure required is reached, and consists of the Relief Valves I attached to either end of the cylinder, and are operated by a differential valve (See page 7) with pressure from receiver. When the pressure reaches the desired point the Valves I are opened, allowing the air to circulate from one end of the piston to the other; at the same time the air acts on the governor of the engine, cutting off the steam at such a point that the engine will just turn over; as the pressure falls, the valves close and the engine takes up load as before.

On water wheels the regulator shuts off the water gate and slowly closes off the water from water wheels, opening again when more pressure is required On Compressors operated by tight and loose pulleys, the regulator operates the bell shifter.

Our regulators are patented, and only used on our make of Compressors.

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DESCRIPTION OF RISDON CORLISS AIR COMPRESSORS

High Pressure, Cross Compound, Tandem Compound or Triple Expansion

THE FRAMES are of the Girder type, made very strong, and provided with a center support, with feet spread well apart, insuring great stiffness and strength.

THE CYLINDERS are made of the best selected close-grained charcoal iron, mixed with selected scrap, and are of proper strength and thickness for operating with 125 pounds steam pressure after having been rebored once. The material is such that the wearing surfaces become polished after a few days' use, after which, with reasonably dry steam, the wear amounts to so little, that the piston remains tight for an indefinite length of time. The cylinders are neatly lagged, and the space between lagging and cylinder packed with non-conducting material, to prevent condensation as much as possible. The steam passages are short and direct, reducing clearance to the least possible amount. The cylinder is supported upon two pedestals with extended base, with ample bearing surface on the foundation. The vacuum dash pots are secured firmly to the sides of these pedestals. Strong lugs are provided for connecting the air cylinders tandem by means of suitable tie rods.

THE STEAM PISTONS are what is known as the double ring type. There are two bull rings and a self-expanding steam ring, re-enforced by eliptic springs. The piston is so constructed that by taking off the follower the bull rings and steam rtngs can be taken off without removing the piston. This is a great convenience, as it is sometimes necessary to examine the steam ring. It is a very durable construction, for the reason that the bull rings and steam ring can at any time be replaced at small expense, and the piston then is practically as good as new.

THE SHAFTS are of the best wrought iron, of extra large diameter, and turned, keyseated and nicely finished. The bearinns are polished to reduce friction to the lowest point.

THE MAIN BEARINGS.—The main pillow blocks are provided with removable shell boxes, with quarter boxes lined with genuine Babbit metal, hammered and strapped to fit the shaft. Approved means for taking up all lost motion is provided. The bearings are of ample length, and large oil boxes are provided, with means for ready access to the shaft. The bearings run smoothly, cool and quiet under the heaviest loads.

THE CRANKS are of the best selected charcoal iron, and of ample strength and proportion for the work to be done; they are of the disk pattern, and the weight of the connecting rod and crank pin are counterbalanced on the opposite side, thus reducing end motion and vibration to the minimum. They are pressed on the shaft by hydraulic pressure, and securely keyed. The faces are planed and polished

THE FLY-WHEELS are extra heavy, of square rim pattern, the faces and edges being turned practically true. The arms are of ample strength and well proportioned. The larger sizes are made in segments, accurately planed and fitted together with turned bolts in reamed holes. Rims of wheels are provided with starting bar holes.

THE CONNECTING RODS are of forged steel, with solid ends and key adjustment. The cross-head end is fitted with phosphor-bronze box, and the crank end with a composition box, bored and scraped to fit the pin.

THE CROSS-HEADS are provided with adjustable shoes for taking up all wear. The guides are bored and scraped to a perfect surface. The shoes are lined with Babbit metal, hammered and scraped to a perfect bearing in the slides. The cross-head pins are of forged steel, turned, polished and fitted to the cross-head by a double taper. They are easily removed and securely held in place with a nut or cap.

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THE VALVE GEAR is of our latest improved Corliss liberating type, fitted with vacuum dash pots. The connecting rods and pins are all of the best forged steel, and are fitted with phosphor-bronze bearings, adjustable for wear; provision for thorough lubrication is made, and the entire gear motion works smoothly and quietly. The catch blocks are of hardened steel.

THE VALVES are slotted at one end to receive the Tee shaft heads of the valve stems, and are so constructed that any valve can be taken out without disturbing the valve stems or changing the adjustment of the valve gear. It is only a few minutes' work to take all the valves out of the Corliss Engine and put them back again, and can be done by any engineer.

THE GOVERNOR is of the fly ball type, provided with an automatic safety stop, and furnished with approved means for adjusting the speed by hand, within the widest possible limits, without altering the throttle valve.

THE THROTTLE VALVES are furnished with flanges and large hand wheels, nicely turned and finished. A brass drain pipe leading to the exhaust is provided.

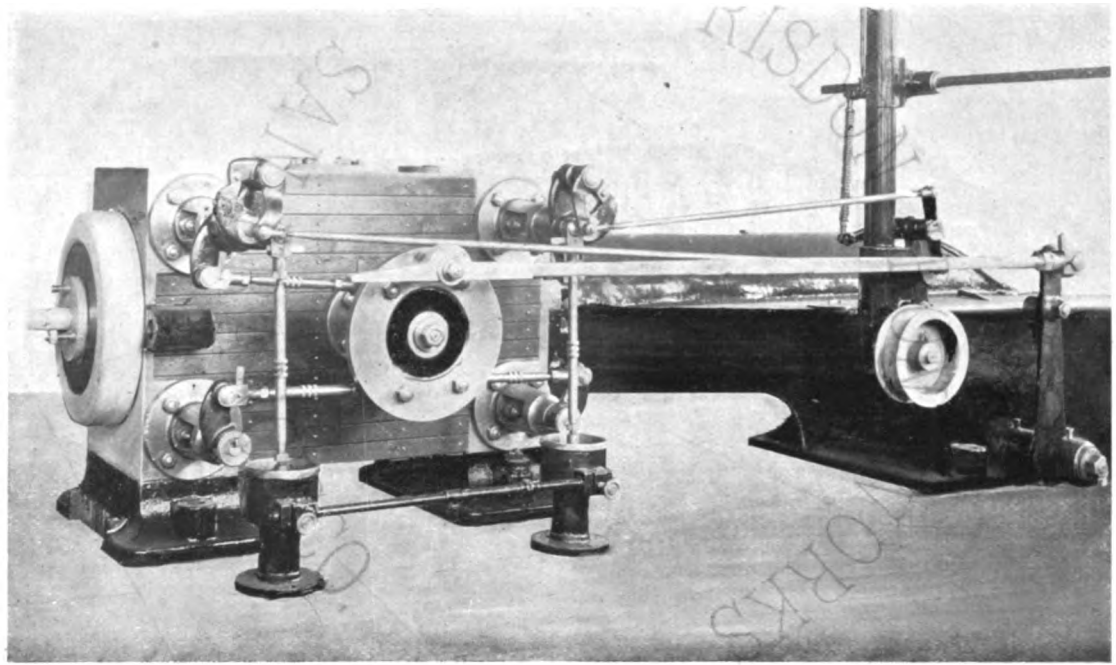
All usual oil cups and sight feed lubricators for air and steam cylinders are provided, of extra large size. A hand pump for steam cylinders and centrifugal oilers for cranks are also supplied, the lubrication being automatic throughout.

Indicator connections are furnished for each steam cylinder, with valve at each end.

A full set of wrenches for adjusting all bolts and nuts, with necessary eyebolts, is supplied.

All necessary holding down bolts with anchor plates, together with foundation plans, are furnished.

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Special Corliss Valve Gear used on our Corliss Engine

Cutting off from 0 to 7-10 of stroke.

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RISDON HIGH PRESSURE DUPLEX AND HALF DUPLEX CORLISS AIR COMPRESSORS WITH RISDON RING INLET AIR CYLINDERS

Air Pressure 100 lbs.

Size No.	Sizes of Cylinders: Diameter: Steam Inches	Sizes of Cylinders: Diameter: Air Inches	Stroke Inches	Revolutions per Minute	Piston Speed in Feet per Minute	Capacity Duplex: Cubic Feet Free Air: Per Min.	Capacity Duplex: Cubic Feet Free Air: Per Rev.	Indicated Horse Power Duplex
1	10½	10	30	90	450	547	6.080	110
2	12	12	30	87	435	684	7.865	138
3	14	14	36	85	510	1080	12.71	218
4	14	14	42	82	574	1216	14.83	244
5	16	16	36	82	492	1359	16.58	274
6	16	16	42	78	546	1509	19.34	304
7	18	18	36	80	480	1674	20.92	336
8	18	18	42	78	546	2061	25.76	382
9	18	18	48	75	590	1904	24.41	422
10	20	20	42	75	525	2093	27.90	454
11	20	20	48	72	576	2473	34.35	498
12	22	22	42	75	525	2718	36.24	546
13	22	22	48	72	579	2982	41.41	601
14	24	24	42	75	525	3211	42.82	646
15	24	24	48	70	560	3425	48.93	690
16	26	26	48	70	560	4033	57.62	813
17	38	28	48	68	544	4559	67.05	919
18	30	30	48	65	520	5015	77.16	1011
19	30	30	60	62	620	5980	96.45	1205
20	32	32	48	65	520	5718	87.97	1153
21	32	32	60	62	620	6817	109.96	1373

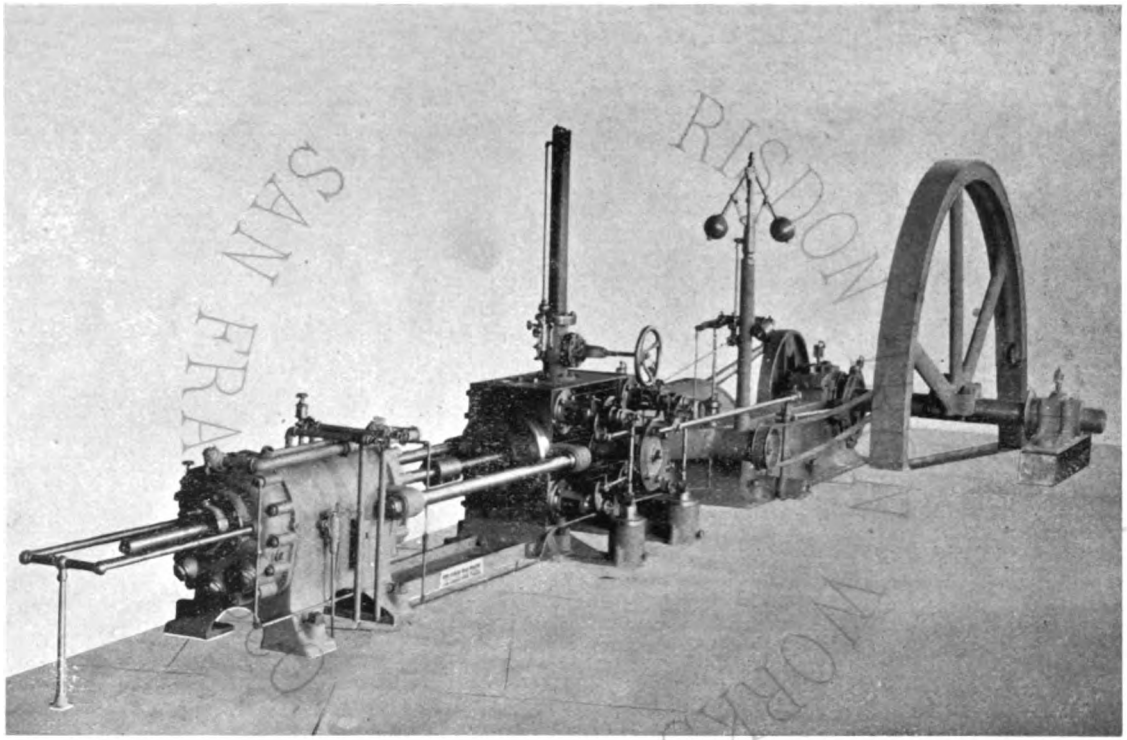
Air Pressure 80 lbs.

2	10½	12	30	90	450	708	7.865	97
22	12	14	30	78	435	921	10.59	163
23	14	16	36	85	510	1409	16.58	249
24	15	16	42	82	574	1586	19.34	281
26	16	18	36	82	492	1716	20.92	303
27	16	18	42	78	546	1904	24.41	237
28	18	20	36	80	480	2061	25.76	365
29	18	20	42	78	546	2344	30.05	415
30	18	20	48	75	590	2576	34.35	456
31	20	22	42	75	525	2718	36.24	480
32	20	22	48	72	576	2982	41.41	528
33	22	24	42	75	525	3211	42.82	569
34	22	24	48	72	576	3523	48.93	625
35	24	26	42	75	525	3782	50.42	670
36	24	26	48	70	560	4033	57.62	715
37	26	28	48	70	560	4693	67.05	830
38	28	30	48	68	544	5247	77.16	927
39	30	32	48	65	520	5718	87.97	1013
40	30	32	60	62	620	6817	109.96	1207
41	32	34	48	65	520	6427	98.88	1138
42	32	34	60	62	620	7662	123.58	1357

These Compressors are all made with Risdon Ring Inlet Air Cylinders. Air cylinders and heads are water jacketed. Steam cylinders neatly lagged.

These Compressors are furnished with governor, provided with automatic safety stop; and with pressure regulator and unloading device on air cylinders. Sight feed lubricators on [illegible] air cylinders, and all necessary oil cups. Foundation bolts and anchor plates. [illegible]dation plans furnished with each Compressor

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Risdon Half-Duplex Corliss Air Compressor.

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TABLE SHOWING SOME OF THE MOST IMPORTANT

Dimensions of Risdon High Pressure Corliss Air Compressors

WITH

Risdon Ring Inlet Air Cylinders

Air Pressure 100 lbs.

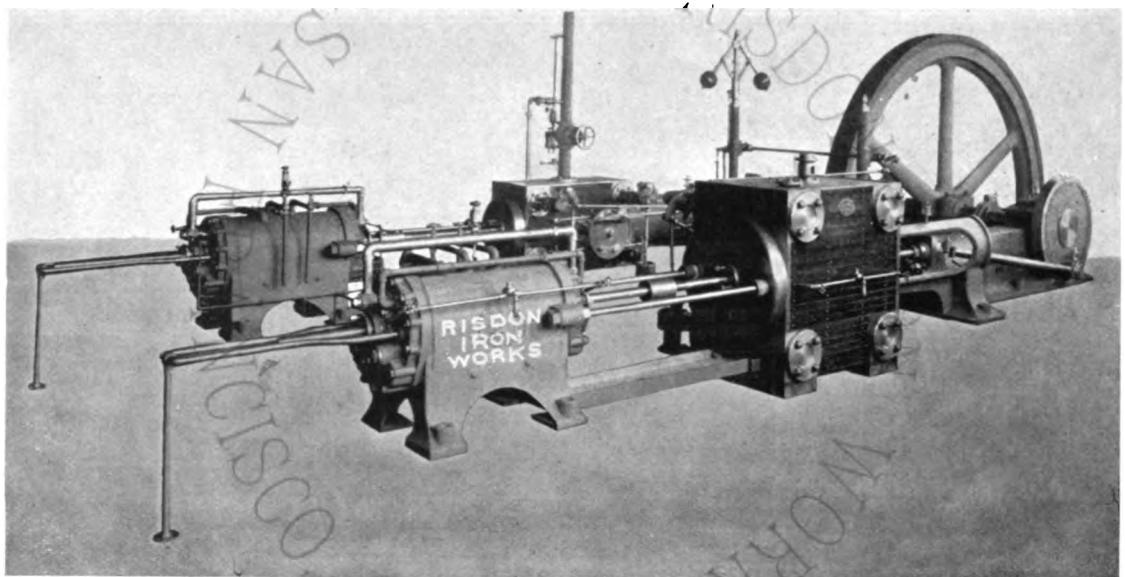
Size Number.	Size of Pipes in Inches.				F. W. & Shaft in Inches.					Approximate Weight.		
	Main Steam Pipes.	Each Steam Inlet.	Exhaust Outlet.	Each Air Outlet.	Circulating Water.	Diameter of Flywheel.	Diameter Shaft in Bearings.	Diam. Shaft between Bearings.	Floor Space in Feet and Inches.	Flywheel.	Half Duplex.	Duplex.
1	5	3	5	3	1	9	6	7	31 x 10	10000	27120	38090
2	5	3½	5	3	1	10	6	7	31 x 10	10400	29320	41290
3	6	4	6	3½	1	10	7	9	34 x 12	13500	36440	51500
4	6	4	6	3½	1	12	7	9	38 x 12	15000	40390	57140
5	6	4½	6	4	1	14	8	10	36 x 12	15000	46930	66400
6	6	4½	6	4	1	16	8	10	40 x 12	17500	51220	71880
7	7	5	7	5	1¼	16	9	11	38 x 13	20000	54000	75310
8	7	5	7	5	1¼	16	9	11	40 x 13	22000	57850	79890
9	7	5	7	5	1¼	18	9	11	46 x 13	25000	67850	96240
10	9	6	8	5	1¼	16	10	12	41 x 13	25000	69500	94650
11	9	6	8	5	1¼	18	10	12	47 x 13	30000	79300	108100
12	9	6	8	6	1¼	18	11	13	42 x 14	30000	80750	111850
13	9	6	8	6	1¼	18	11	13	47 x 14	36000	88550	119300
14	10	7	9	6	1½	20	12	14	43 x 14	56000	97200	131800
15	10	7	9	6	1½	20	12	14	49 x 15	38000	103700	142150
16	12	8	12	7	1½	20	13	15	49 x 15	45000	117950	161200
17	12	8	12	7	1½	20	14	16	49 x 16	50000	135800	184100
18	12	8	12	8	1½	22	15	17	41 x 16	55000	148570	203540
19	12	8	12	8	1½	21	15	17	59 x 17	60000	169150	240900
20	13	9	13	8	1½	22	16	18	41 x 19	60000	163400	236800
21	13	9	13	8	1½	24	16	18	60 x 19	80000	190000	280000

Air Pressure 80 lbs.

22	5	3	5	3	1	9	6	7	31 x 10	10000	27330	385 0
23	5	3½	5	3	1	10	6	7	31 x 10	10400	29520	41690
24	6	4	6	4	1	10	7	9	34 x 12	13500	37140	52900
25	6	4	6	4	1	12	7	9	38 x 12	15000	41040	58440
26	6	4½	9	5	1¼	14	8	10	36 x 12	15000	48130	68800
27	6	4½	6	5	1¼	16	8	10	40 x 12	17500	52470	74380
28	7	5	7	5	1¼	16	9	11	38 x 13	20000	54200	75710
29	7	5	7	5	1¼	16	9	11	40 x 13	22000	58940	82090
30	7	5	7	5	1¼	08	9	11	46 x 13	25000	68950	98440
31	9	6	8	6	1¼	06	00	12	41 x 13	25000	90900	95450
32	9	6	8	6	1¼	08	00	12	47 x 13	30000	79800	109100
33	9	6	8	6	1½	08	00	13	42 x 14	30000	82250	114850
34	9	6	8	6	1½	08	00	13	47 x 14	36000	90750	123700
35	10	7	9	7	1½	20	02	14	43 x 14	36000	99200	135800
36	10	7	9	7	1½	20	02	14	49 x 15	38000	105700	146150
37	12	8	12	7	1½	20	03	15	49 x 15	45000	118450	162200
38	12	8	12	8	1¼	20	04	16	49 x 16	50000	136800	187100
39	12	8	12	8	1½	22	05	17	41 x 16	55000	149470	205340
40	12	8	12	8	1½	24	05	17	59 x 17	50000	169650	241900
41	13	9	13	8	1½	22	06	18	41 x 19	60000	164750	239500
42	13	9	13	8	1½	24	06	18	60 x 19	70000	191000	282000

Duplex illustrated page 13.
Half Duplex illustrated page 15

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RISDON DUPLEX RING INLET COMPRESSOR

With Cross Compound Corliss Engine.

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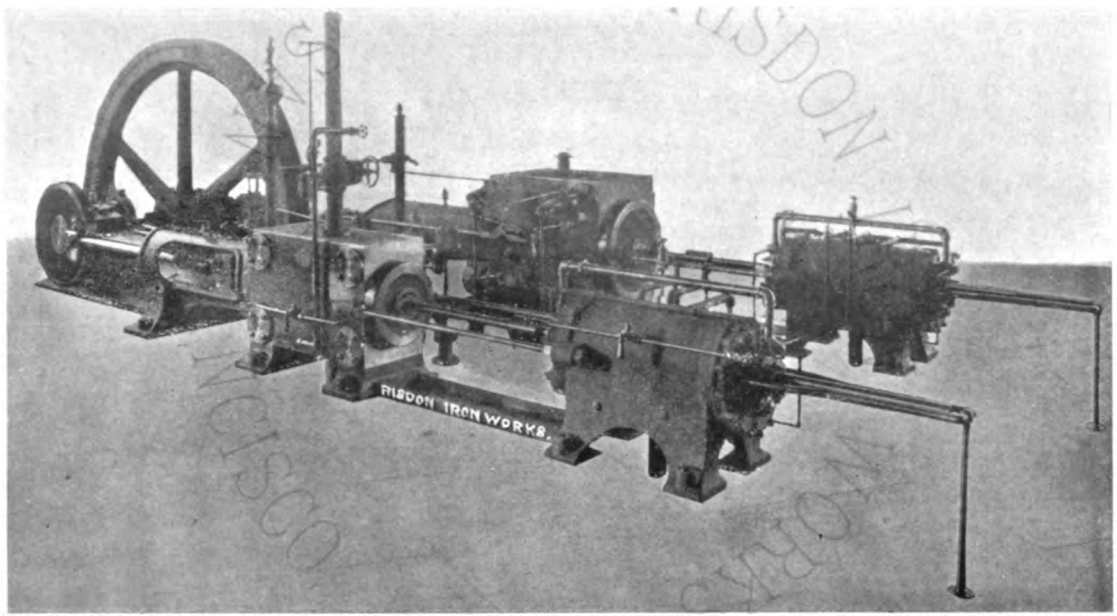
Risdon Cross Compound Corliss Air Compressors

With Cross Compound Steam Cylinders and Risdon Ring Inlet Air Cylinders

Air Pressure 100 lbs.

Size Number.	Size of Cylinders in Inches. Diameters. Steam. High Pressure.	Low Pressure.	Air.	Length of Stroke.	Revolutions Per Minute.	Piston Speed in Feet Per Minute.	Capacity Duplex. Cubic Feet Free Air. Per Minute.	Per Revolution.	Horse Power. I. H. P. of Comp.	Boiler H. P. Condensor Attached.
43	10½	18	10¾	30	90	450	547	6.08	110	65
44	12	22	12	30	87	435	684	7.86	138	85
45	14	26	14	36	85	510	1080	12.71	218	130
46	16	30	16	36	82	492	1359	16.58	274	165
47	14	26	14	42	82	574	1216	14.83	244	145
48	16	30	16	42	78	546	1509	19.34	304	180
49	18	34	18	36	80	480	1674	20.92	336	200
50	18	34	18	42	78	546	1904	24.41	382	230
51	20	36	20	36	80	480	2061	25.76	414	250
52	20	36	20	42	75	525	2254	30.05	454	270
53	18	34	18	48	75	590	2093	27.90	422	250
54	20	36	20	48	72	576	2473	34.25	498	300
55	22	40	22	42	75	525	2718	36.24	546	330
56	22	40	22	48	72	576	2982	41.41	600	360
57	24	44	24	42	75	525	3211	42.82	546	390
58	24	44	24	48	70	560	3425	48.93	690	415
59	26	48	26	48	70	560	4033	57.62	812	485
60	28	52	28	48	68	544	4559	67.05	920	550
61	30	56	30	48	65	520	5015	77.16	1011	600
62	30	56	30	60	62	620	5980	90.45	1205	725

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Risdon Duplex Air Compressor with Cross Compound Corliss Engine

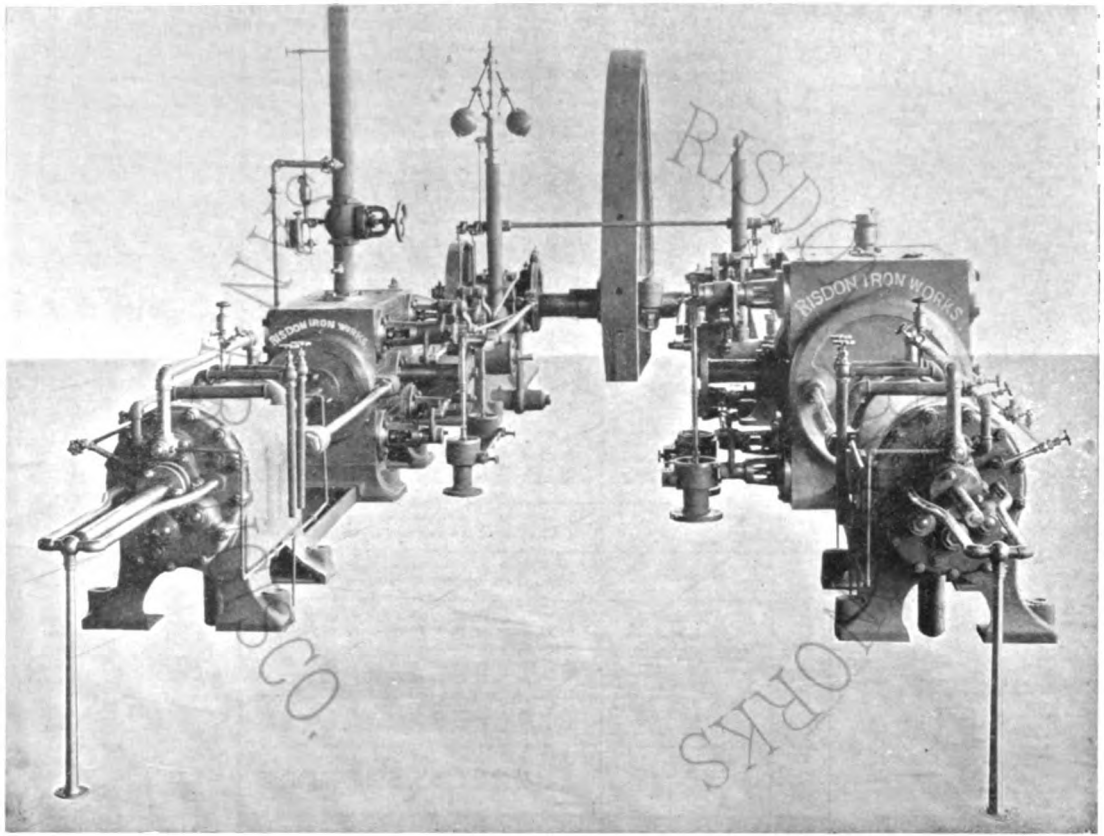
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Dimensions of Risdon Cross Compound Corliss Engines with Risdon Ring Inlet Air Compressing Cylinders.

Air Pressure 100 Pounds.

Size Number.	Sizes of Pipes, Inches.				Flywheel and Shaft.			Floor Space, Feet.	APPROXIMATE WEIGHTS.			
					Diameter.					Complete Compressor.		
	Steam Pipes.	Exhaust Outlet.	Each Air Outlet.	Circulating Water.	Flywheel, ft.	Shaft. In. In Bearings	Shaft. In. Between Bearings		Flywheel.	With Surface Condensor.	With Jet Condensor.	Without Condensor.
43	3	5	3	1	9	6	7	34 x 14	10000	48000	47000	43000
44	3½	5	3	1	10	6	7	34 x 14	10000	52000	50000	46000
45	4	6	3½	1	10	7	9	38 x 14	16500	69000	68000	62000
46	4½	6	4	1	14	8	10	40 x 15	21000	91000	89000	82000
47	4	6	3½	1	12	7	9	42 x 14	18500	76000	75000	69000
48	4½	6	4	1	16	8	10	44 x 15	23000	97000	94000	88000
49	5	7	5	1¼	16	9	11	42 x 16	29000	106000	104000	97000
50	5	7	5	1¼	16	9	11	44 x 16	31500	115000	110000	103000
51	6	8	5	1¼	16	10	12	42 x 16	31500	120000	111000	108000
52	6	8	5	1¼	16	10	12	45 x 16	32500	129000	124000	116000
53	5	7	5	1¼	18	19	11	50 x 16	32500	129000	123000	116000
54	6	8	5	1¼	18	10	12	51 x 16	33000	140000	134000	126000
55	6	8	6	1¼	18	11	13	46 x 18	40000	151000	146000	138000
56	6	8	6	1¼	18	11	13	51 x 18	44000	160000	156000	145000
57	7	9	6	1½	20	12	14	48 x 19	46000	178000	171000	159000
58	7	9	6	1½	20	12	14	53 x 19	50000	194000	184000	173000
59	8	12	7	1½	20	13	15	53 x 21	60000	225000	218000	202000
60	8	12	7	1½	20	14	16	53 x 21	65000	264000	257000	237000
61	8	12	8	1½	22	15	17	55 x 22	75000	295000	287000	267000
62	8	12	8	1½	24	15	17	64 x 22	90000	348000	336000	314000

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Risdon Duplex Air Compressor with Cross Compound Corliss Engine

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Risdon Cross Compound Corliss

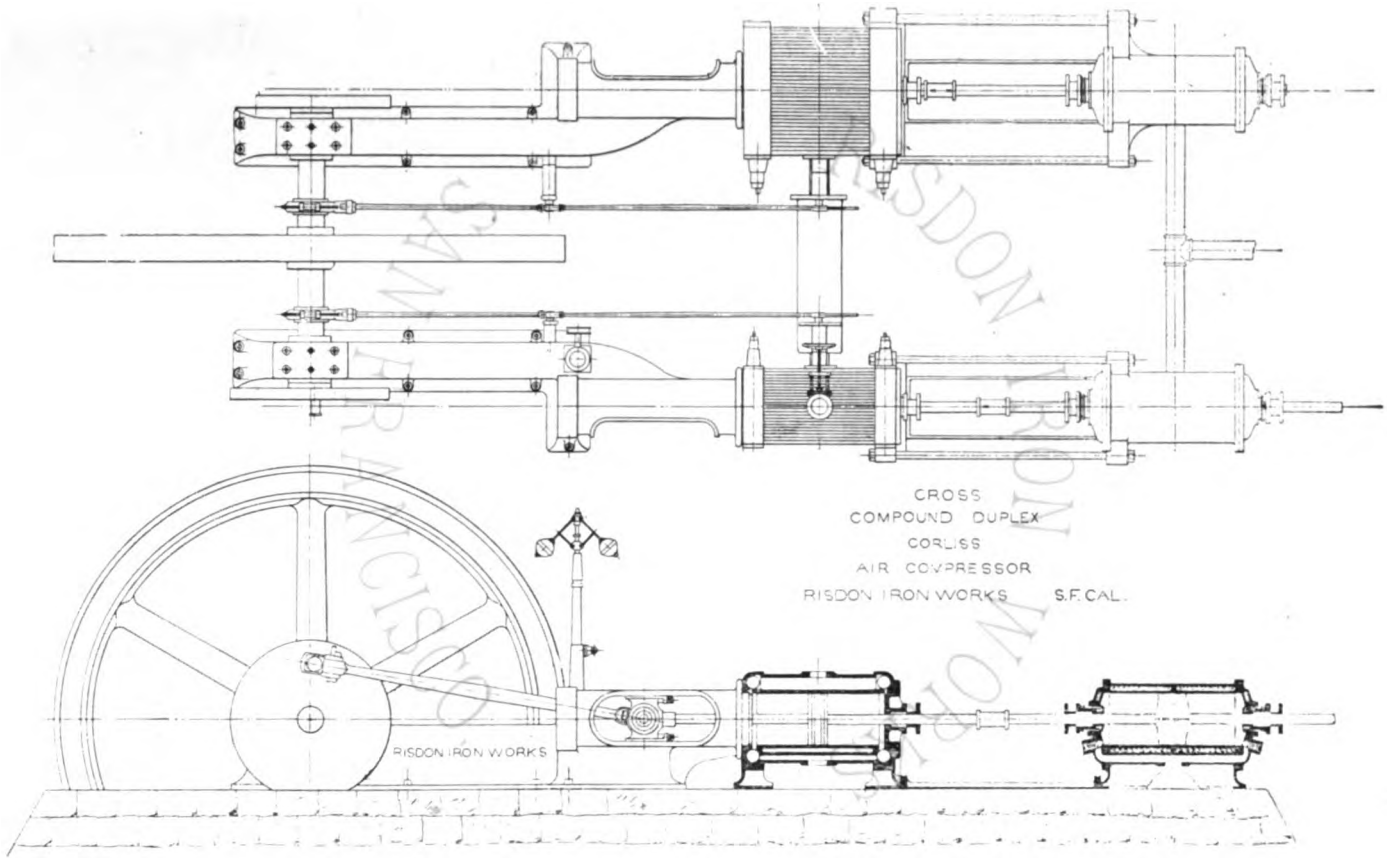
With Cross Compound (2 stage) Air Cylinder.

Air Pressure 100 lbs.

Size Number.	Size of Cylinders in Inches. Diameters. Steam. High Pressure.	Steam. Low Pressure.	Air. Low Pressure.	Air. High Pressure.	Stroke.	Revolutions per Minute.	Piston Speed in Feet per Minute.	Capacity. Cubic Feet Free Air. Per Minute.	Per Revolution.	Horse Power. I. H. P. of Comp.	Boiler H. P. Condensor Attached.	Intercooler. Diameter in Inches.	Length in Feet.
63	10½	18	16	10	30	90	450	571	6.35	97	60	36	8
64	12	22	18	11	36	85	510	889	10.46	152	90	36	8
65	12	22	18	11	42	82	574	1000	12.20	170	100	36	8
66	14	26	22	13	36	85	510	1325	15.60	225	135	42	9½
67	14	26	22	13	42	82	574	1489	18.12	253	150	42	9½
68	16	30	24	14	42	78	546	1670	21.41	284	170	42	9½
69	16	30	24	14	48	75	600	1834	24.46	312	185	42	9½
70	16	30	26	15	42	78	546	1980	25.21	337	200	42	9½
71	16	30	26	15	48	75	600	2160	28.81	367	220	42	9½
72	18	34	28	17	48	75	600	2513	33.52	427	250	48	11
73	20	36	30	18	48	72	576	2777	38.58	471	280	48	11
74	22	40	32	19	48	72	576	3160	43.98	540	325	48	11
75	22	40	34	20	48	72	576	3558	49.44	604	360	60	13½
76	22	40	34	20	60	65	650	4016	61.79	685	415	60	13½
77	24	44	36	22	48	70	560	3904	55.78	664	400	60	13½

These Compressors are all made with Risdon Ring Inlet Air Cylinders. Air cylinders and heads are water jacketed. Steam cylinders neatly jacketed. These Compressors are furnished with governor, provided with automatic safety stop; and with pressure regulator and unloading device on air cylinders. Sight feed lubricators on steam and air cylinders, and all necessary oil cups. Foundation bolts and anchor plates. Foundation plans furnished with each Compressor.

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Risdon Cross Compound Corliss Engine and Ring Inlet Air Cylinders

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DIMENSIONS

OF

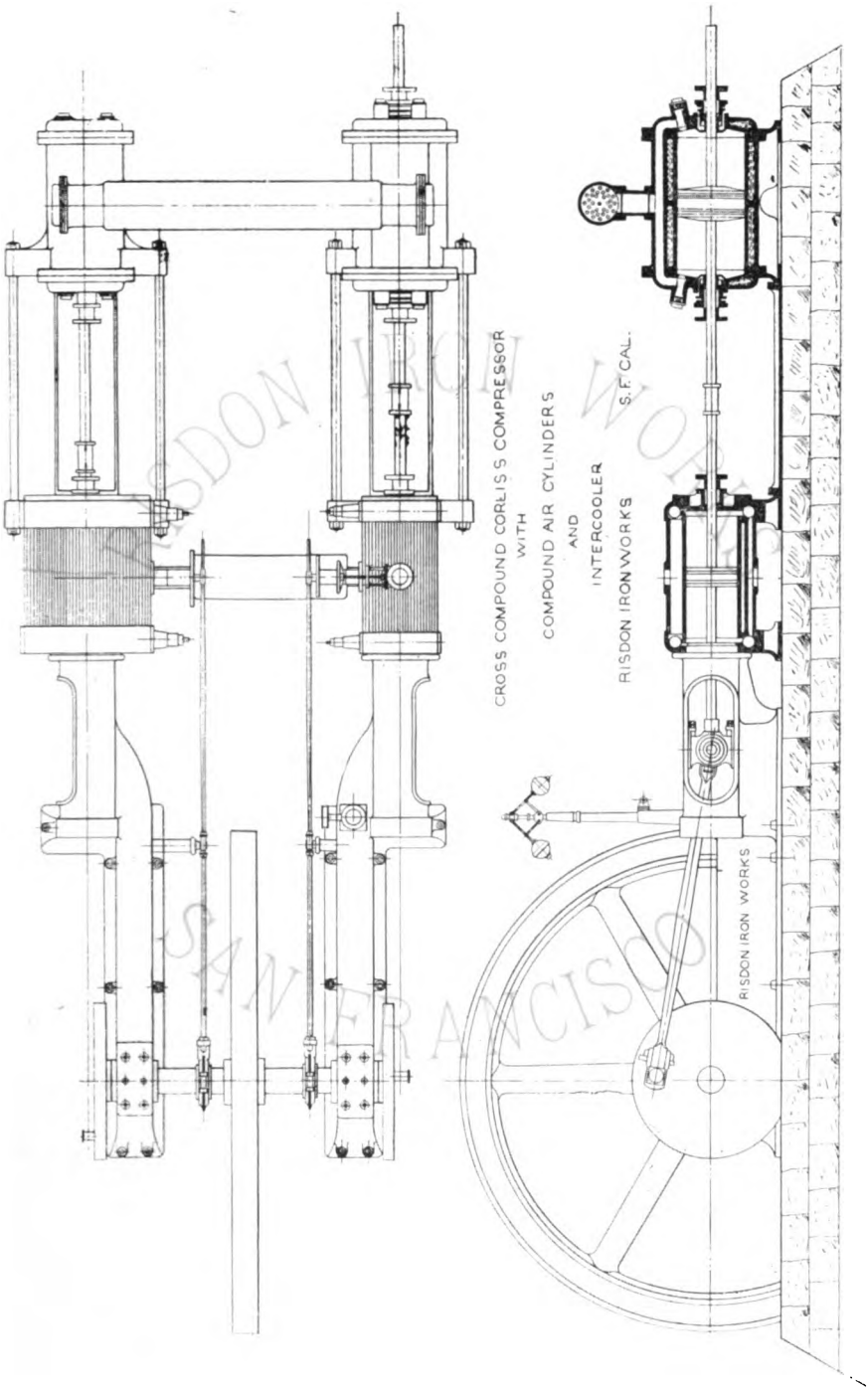
Risdon Cross Compound Corliss

WITH

CROSS COMPOUND (2 STAGE) RISDON RING INLET AIR CYLINDER.

Size Number.	Sizes of Pipes. Inches.				Flywheel, Shaft Diameter.			Floor Space, Feet.	APPROXIMATE WEIGHTS.			
	Steam Pipe.	Exhaust Outlet.	Air Outlet.	Circulating Water.	Flywheel. Ft.	Shaft, In. In Bearings.	Shaft, In. Between Bearings.	(Not Allowing for Condensor.)	Flywheel.	Surface Condensor.	Jet Condensor.	Without Condensor.
63	3	5	3	1	9	6	7	39 x 14	10000	51490	49990	45090
64	3½	5	3½	1¼	10	7	9	43 x 14	13500	63220	61720	57420
65	4	6	3½	1¼	12	7	9	47 x 14	15500	65620	64120	61070
66	4	6	4	1¼	10	7	9	43 x 14	16500	74840	74590	68140
67	4	6	4	1¼	12	7	9	47 x 14	18500	83040	81690	75140
68	4½	6	5	1¼	16	8	10	49 x 15	23000	103330	101080	94530
69	5	7	5	1¼	16	8	10	55 x 15	29000	116430	113780	107230
70	4½	6	5	1¼	16	8	10	49 x 15	23000	105980	103730	97180
71	5	7	5	1¼	16	8	10	55 x 15	29000	118430	115780	109230
72	5	7	6	1½	18	9	11	55 x 16	32500	139840	133840	126840
73	6	8	6	1½	18	10	12	56 x 16	33000	149000	143400	135408
74	6	8	6	1½	18	11	13	56 x 18	44100	169950	166250	155250
75	6	8	6	1½	18	11	13	56 x 18	44100	173300	169600	158600
76	7	9	6	1½	20	11	13	67 x 18	46500	201610	194510	183010
77	7	9	7	1½	20	12	14	58 x 19	50000	205200	195200	183700

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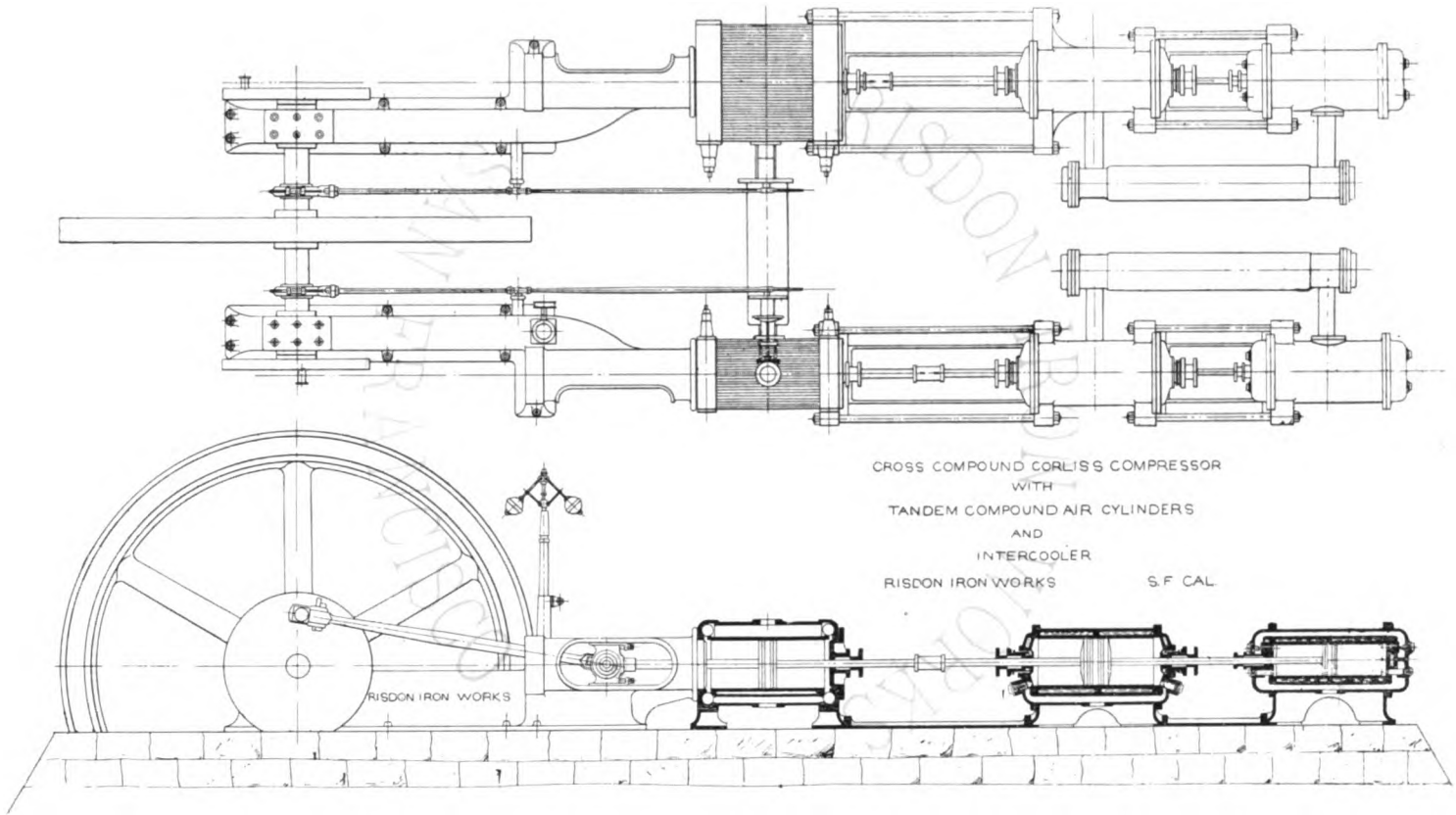
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Risdon Tandem Compound (2 stage and 3 stage) Compressors

We build all sizes of this style of Compressor, also Triple Expansion and Compound Steam Engines for operating same.

We also build all kinds of Vertical Compressors.

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LIST OF SIZES

OF

Meyers' Cut-off Engines

AND

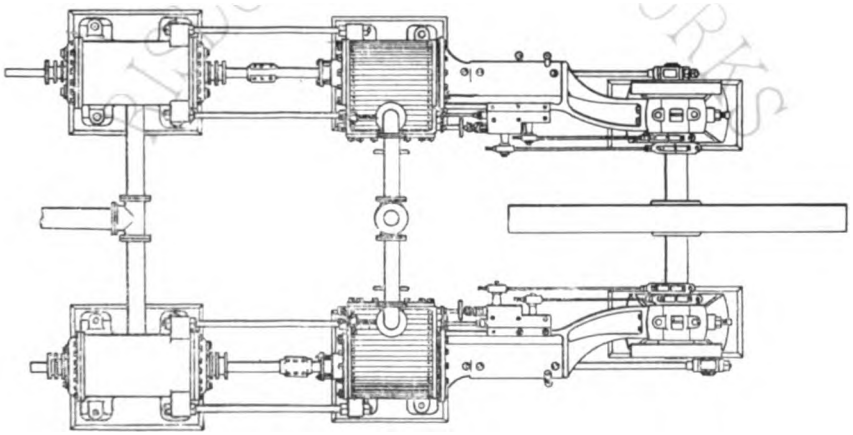
Risdon Ring Inlet Air Cylinders

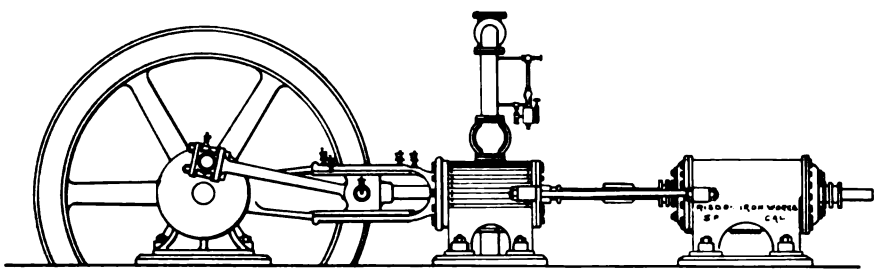
As Illustrated on Page 27

No.	Size of Air Cylinder. Inches.		Revolutions per Minute.	Capacity in Drills. 3 5-16 Cyls.	Horse Power of Boiler Needed.	Diameter of Pipes.					Approximate Shipping Weights. Pounds.
						Steam.			Air.		
						Main From Boiler.	Branch to Each Cylinder.	Exhaust from Each Cylinder.	Main To Receiver.	Branch from Each Cylinder.	Total.
64	10x16	Single.....	100	2	23	2		2½	2½		10000
65		Duplex.....	100	4	45	2½	2	2½	3	2½	14000
66	12x16	Single.....	100	3	35	2½		4	3½		13000
67		Duplex.....	100	6	65	3	2½	4	4	3½	19000
68	14x24	Single.....	85	5	55	3½		5	4		23000
69		Duplex.....	85	10	110	4	3½	5	5	4	33000
70	16x30	Single.....	75	8	88	4		6	5		35000
71		Duplex.....	75	16	175	5	4	5	6	5	52000
72	18x30	Single.....	75	10	105	4		6	5		36000
73		Duplex.....	75	20	210	5	4	6	6	5	55000
74	24x48	Single.....	50	12	140	5		7	6		63000
75		Duplex.....	50	25	280	6	5	7	8	6	99000
76	28x48	Single.....	40	20	215	7		10	7		95000
77		Duplex.....	40	40	430	8	7	10	9	7	145000

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MEYERS' CUT-OFF ENGINE





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Risdon "Straight-Line" Air Compressors

As per Cut Page 29

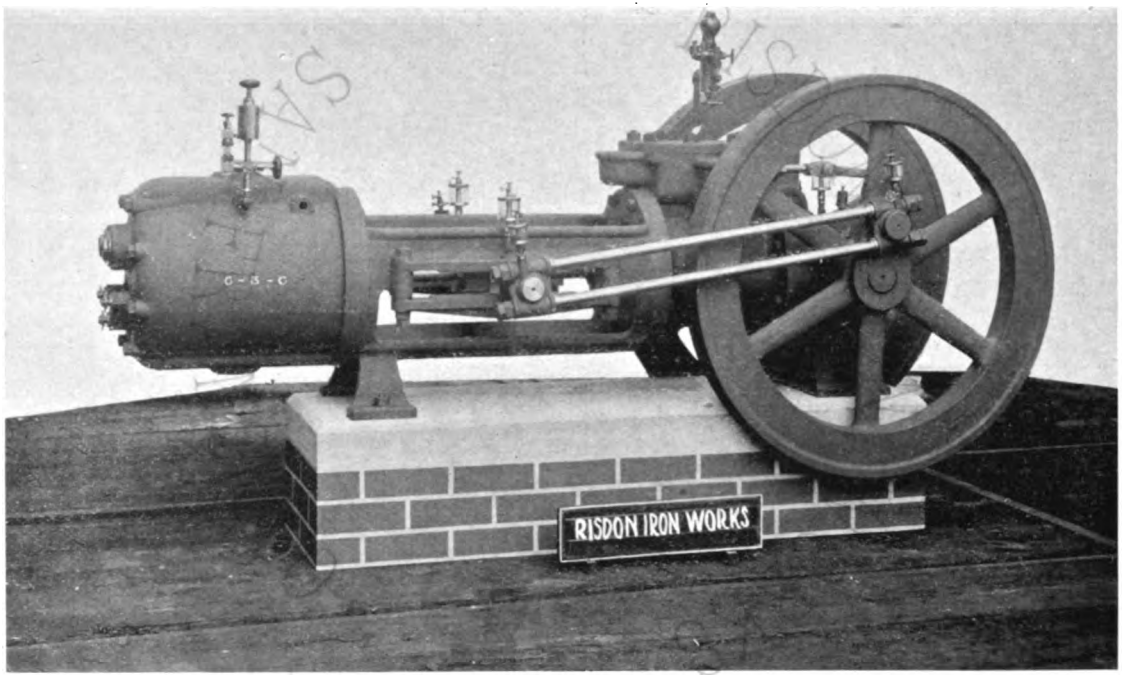
Steam Power Air Compressors

No.	Cylinders. Dia. Steam.	Dia. Air.	Stroke.	R. P. M.	Capacity Free Air.	Air Pressure.
79	10	10	10	150	123	50 to 80
80	12	12	12	150	225	50 to 80
81	12	14	12	150	303	30 to 60

Water Power, Same Style

No.	Dia. Air.	Stroke.	R. P. M.	Capacity Free Air.	Air Pressure.
82	10	10	150	123	50 to 80
83	12	10	150	180	30 to 60
84	12	12	150	225	50 to 80
85	14	12	150	303	30 to 60

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Risdon "Straight Line" Air Compressor

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Risdon Water Impulse Compressors.

The cut on the opposite page and pages 33 and 35, made from the general plan of a 24x48 inch duplex, shows our latest and favorite design for a water-power compressor. An impulse water wheel mounted directly on the compressor shaft, and so designed with relation to the fall and quantity of water as to make the same number of revolutions that the compressor is expected to make, is the simplest way of applying the power of water to the compressing of air. The weight of the wheel is calculated so as to be sufficient to act as a fly-wheel. It will be found convenient to encase the wheel in a wooden box to keep the water from spraying around the compressor. The efficiency of these wheels has been tested to be as high as 95 per cent., and they can be relied upon to render in practice an efficiency of 85 per cent., which is applied directly to the compressor. For very low heads the water nozzle may be multiple so as to have two or more streams of water impinging on the wheel buckets.

The advantages of this design are easily perceived: no belting, no gearing, no shaft transmission, and therefore no loss of power in transmission, and no liability to break down; besides, the wheel is in a position easy to get at.

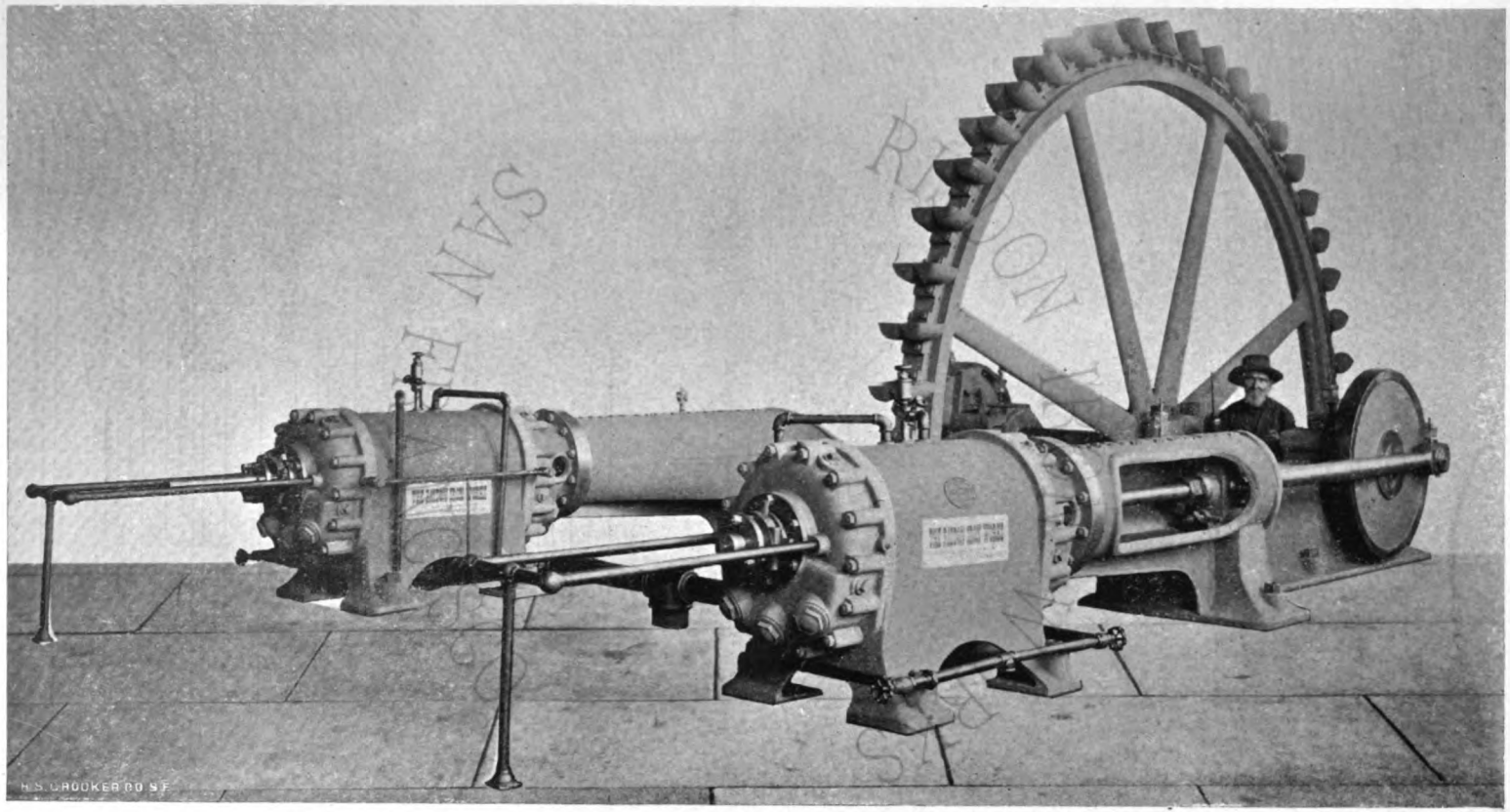
The wheel is governed by an automatic shut-off, so that when pressure is at required point the water is slowly and automatically shut off, starting again when pressure falls.

LIST OF SIZES WATER POWER AIR COMPRESSORS.

Air Pressure 100 Pounds.

Size No.	Sizes of Air Cylinders. Diam. In. Air.	Stroke, In.	Revolutions per Minute.	Piston Speed in Feet per Minute.	CAPACITY DUPLEX. Cubic Feet. Free Air. Per Min.	Per Rev.	Indicated Horse Power. Duplex.
86	10	30	90	450	547	6.080	110
87	12	30	87	435	684	7.865	138
88	14	36	85	510	1080	12.71	218
89	14	42	82	574	1216	14.83	244
90	16	36	82	492	1359	16.58	274
91	15	42	78	546	1509	19.34	304
92	18	36	80	480	1674	20.92	336
93	18	42	78	546	2061	25.76	382
94	18	48	75	590	1904	24.41	422
95	20	42	75	525	2093	27.90	454
96	20	48	72	576	2473	34.35	498
97	22	42	75	525	2718	36.24	546
98	22	48	72	576	2982	41.41	601
99	24	42	75	525	3211	42.82	646
100	24	48	70	560	3425	48.93	690
101	26	48	70	560	4033	57.62	813
102	28	48	68	544	4559	67.05	919
103	30	48	65	520	5015	77.16	1011
104	30	60	62	620	5980	96.45	1205
105	32	48	65	520	5718	87.97	1153
106	32	60	62	620	6817	109.96	1373
107	.....	.....	.....	.....	.....	.....	.....

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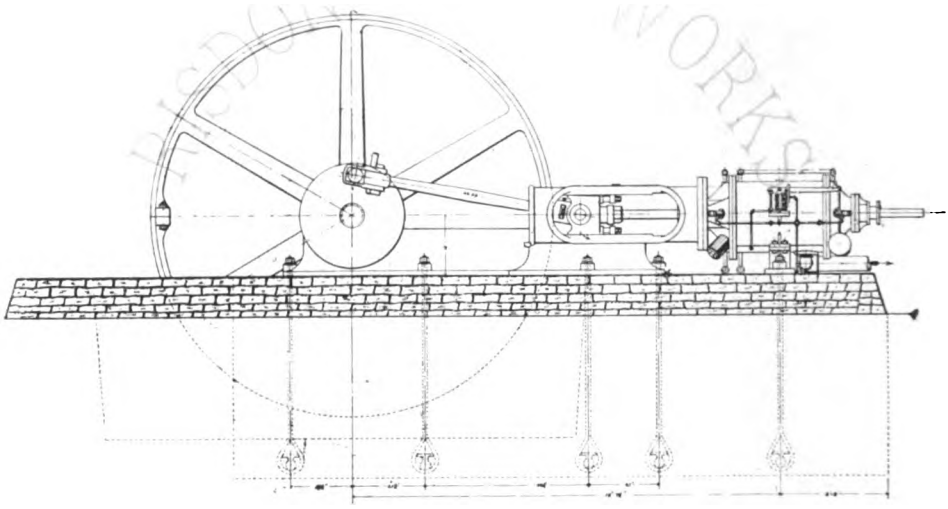
500 Horse Power Risdon Inlet Air Compressor, driven direct by Risdon Water Wheel, 24 ft. diameter. Air Cylinder, 24 in. diameter, 48 in. stroke.

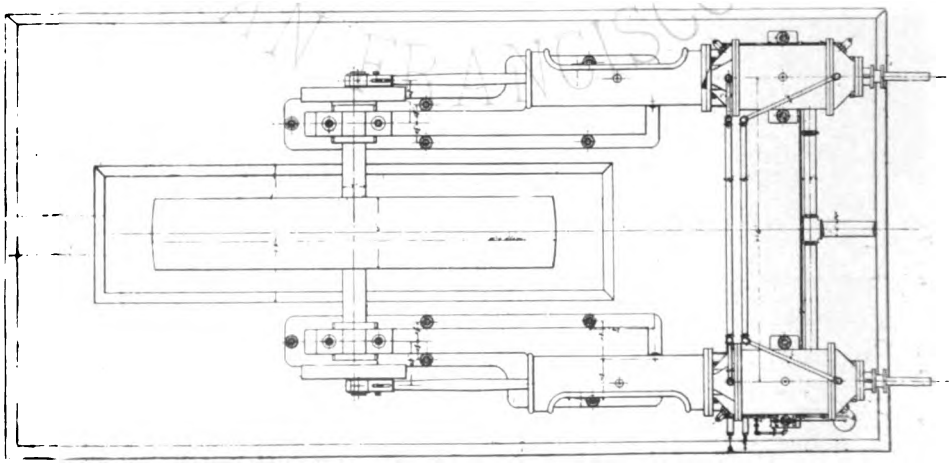
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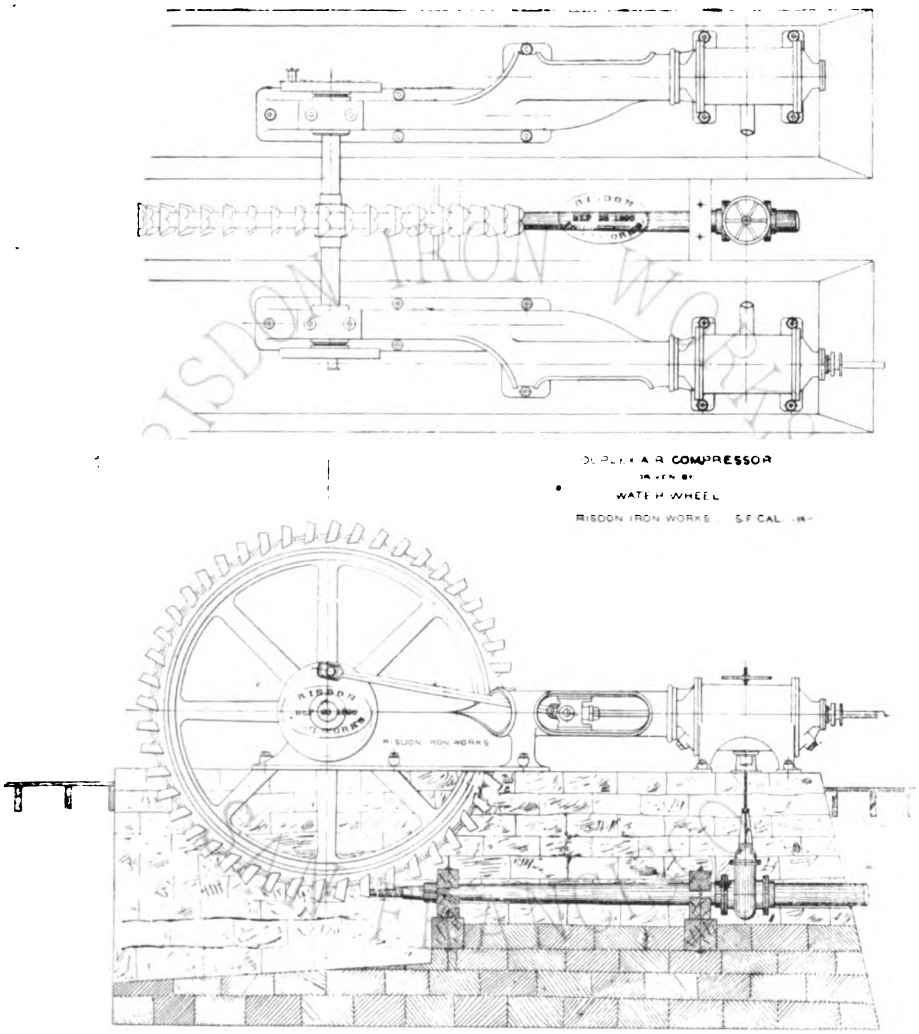
Belt or Geared Air Compressor.

We illustrate on pages 37, 38, 39 one of our belt driven compressors, and while we advocate the use of direct connected water wheels or power to a compressor, sometimes this cannot be done, and an arrangement of this kind necessitates the use of belting, gearing or rope drive. All our compressors are equipped with our unloading device to control work.





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24x48 Risdon Duplex Air Compressor

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Risdon Water Impulse Air Compressor
Compound, (2 stage) Air Cylinders

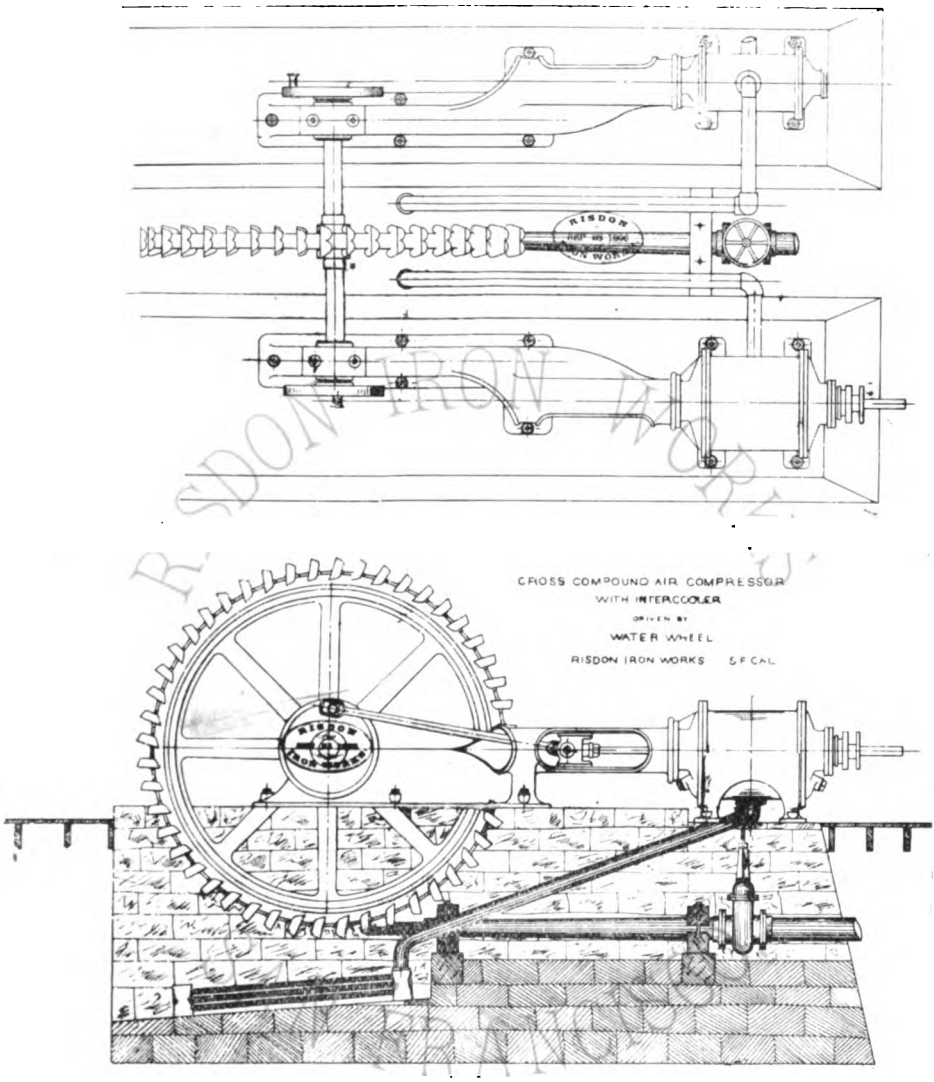
This Compressor, illustrated on page 35, is of the same general description as the single stage illustrated on page 31, except that the air cylinders are compound with intercoolers, and is a very efficient machine. We recommend this type when pressure runs above 100 lbs., or when water has to be purchased.

LIST OF SIZES

Air Pressure 100 lbs.

No.	Size of Air Cylinders in Inches. Diameters. Low Pressure.	High Pressure.	Stroke.	Revolutions per Minute.	Pis on Speed in Feet per Minute.	Capacity. Cubic Feet Free Air. Per Minute.	Per Revolution.	I. H. P. of Comp.
108	16	10	30	90	450	571	6.35	97
109	18	11	36	85	510	889	10.46	152
110	18	11	42	82	574	1000	12.20	170
111	22	13	36	85	510	1325	15.60	225
112	22	13	42	82	574	1489	18.12	253
113	24	14	42	78	546	1670	21.41	284
114	24	14	48	75	600	1834	24.46	312
115	26	15	42	78	546	1980	25.21	337
116	26	15	48	75	600	2160	28.81	367
117	28	17	48	75	600	2513	33.52	427
118	30	18	48	72	576	2777	38.58	471
119	32	19	48	72	576	3160	43.98	540
120	34	20	48	72	576	3558	49.44	604
121	34	20	60	65	650	4016	61.79	685
122	36	22	48	70	560	3904	55.78	664

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Risdon Direct Driven Water Impulse Air Compressor
with Compound (2 stage) Air Cylinders
and Intercooler.

Low Pressure.....42 inch diameter
High Pressure.....24 inch diameter
Stroke.....48 inch diameter

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List of Sizes Belt or Geared Air Compressors.

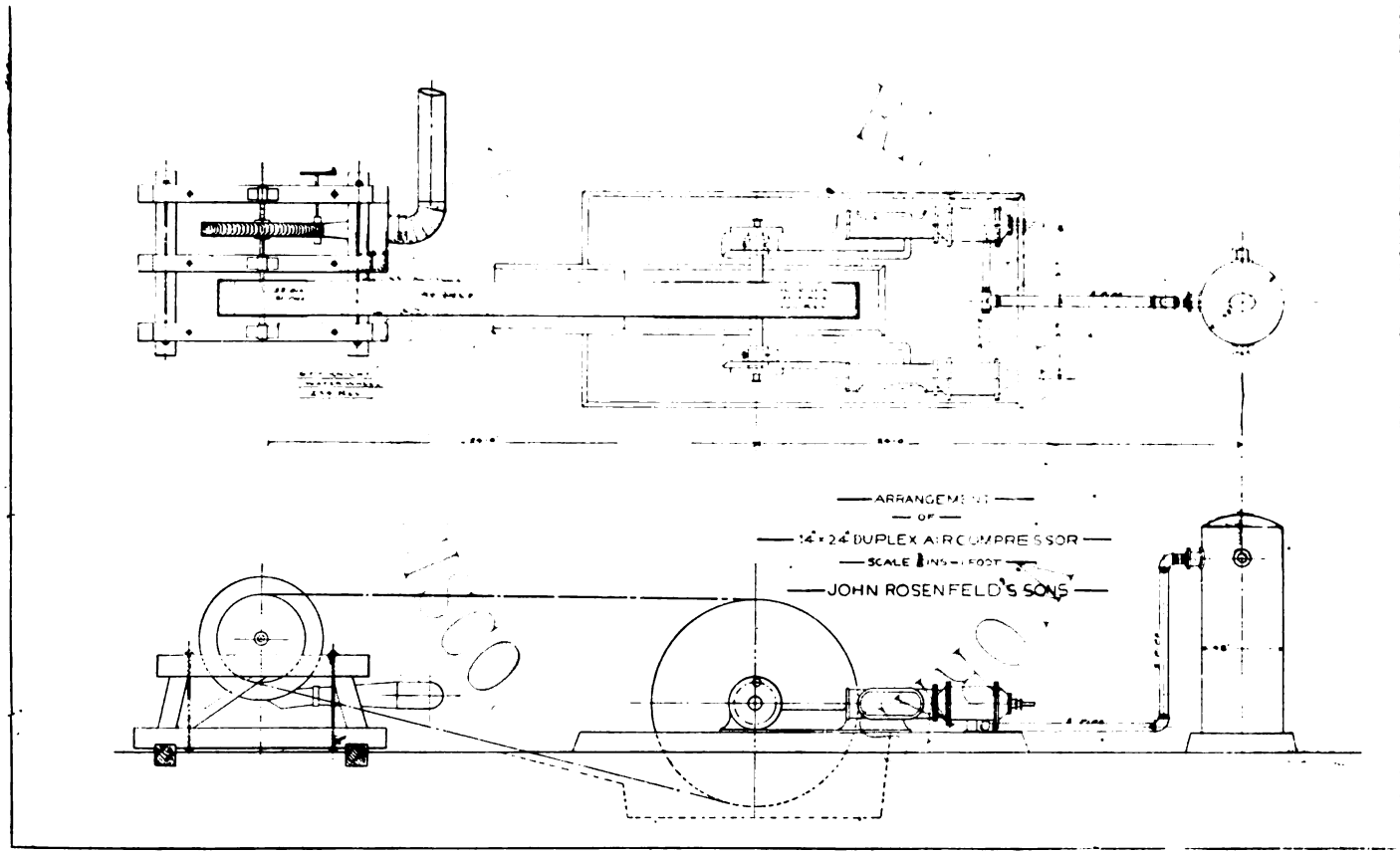
No.	Size of Air Cylinder		Revs. per Min.	Capac. No. 3 Drills.	H. P. Water Wheel.	Size of Pulley. Feet.	Inches.
124	10x16	Single.....	100	2	23	6	x 13
125		Duplex.....	100	4	45	6	x 13
126	12x16	Single.....	100	3	35	6	x 19
127		Duplex.....	100	6	70	6	x 19
128	14x24	Single.....	95	5	60	10	x 21
129		Duplex.....	95	10	120	10	x 21
130	16x24	Single.....	90	7	80	12	x 25
131		Duplex.....	90	14	160	12	x 25
132	18x30	Single.....	80	10	120	12	x 36
133		Duplex.....	80	20	240	12	x 36
134	20x30	Single.....	80	12	140	14	x 36
135		Duplex.....	80	25	280	14	x 36

If spur gear and pinion are required, an additional price will be added.

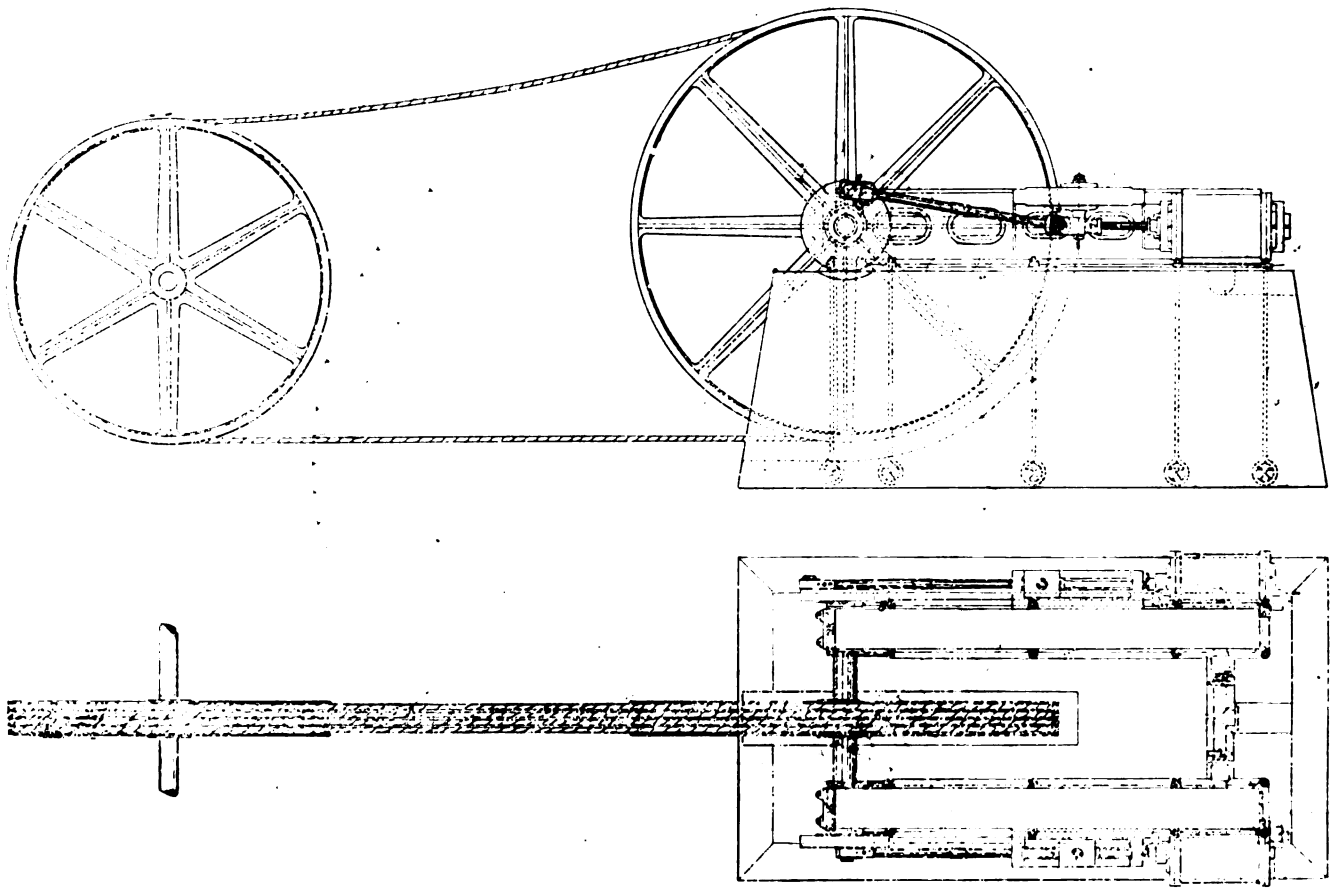
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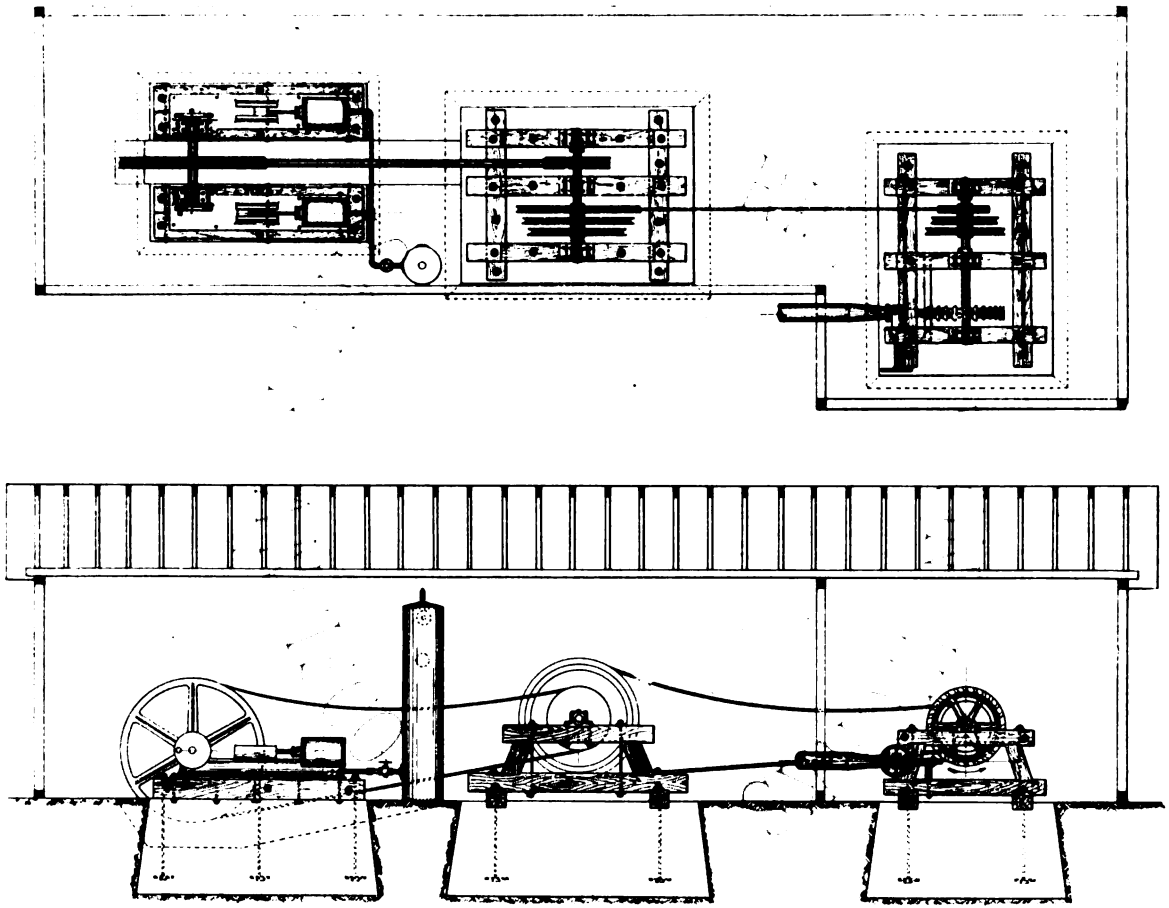


Belt Driven Risdon Ring Inlet Air Compressor. Sizes on Page 36.



Rope Driven Risdon Ring Inlet Air Compressors. Sizes on Page 36

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Double Speed Reduction Rope Driven Ring Inlet Air Compressor—3-speed. Sizes Page 36

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Belt or Water Wheel Compressor for Small Plants

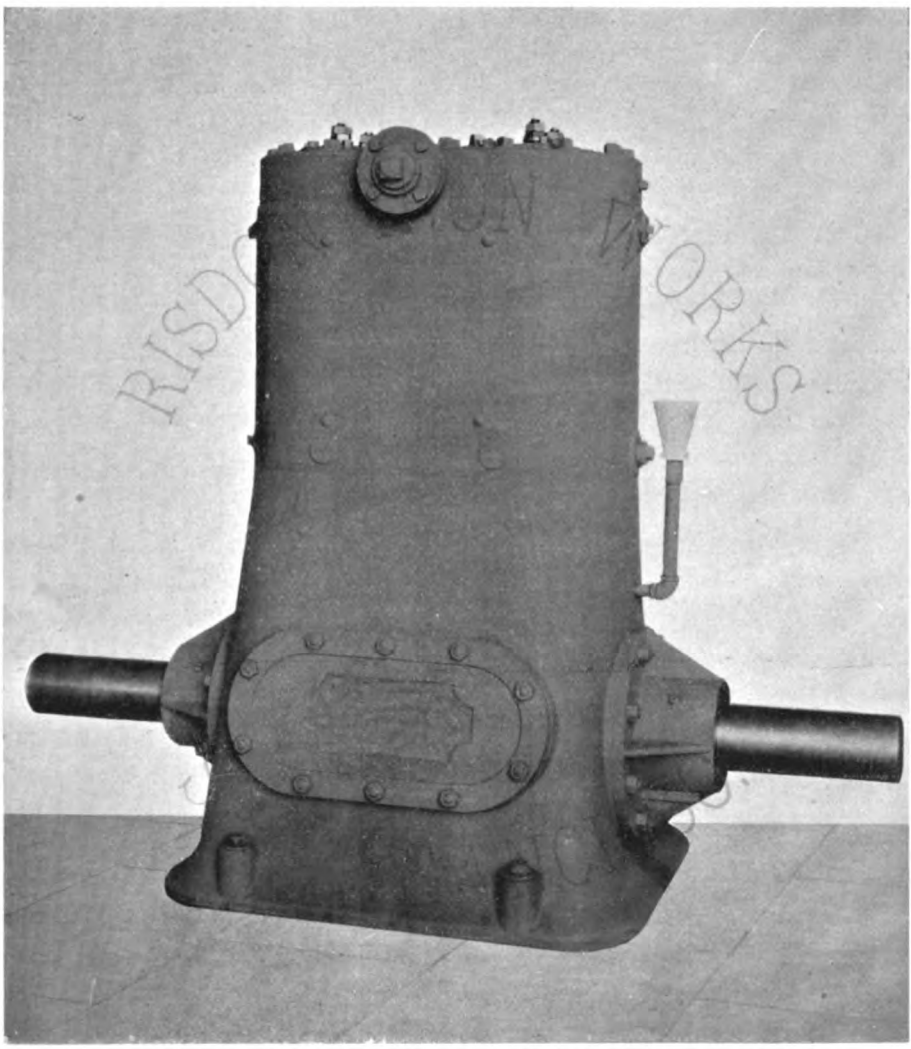
These Compressors are of the Duplex, Single Acting Type, and are very simple and efficient. They are completely water-jacketed, and have exceptionally large valve areas, and have given the most satisfactory results. The cranks run in a mixture of oil and water in the enclosed crank case; the splashing of the crank in this oil lubricates all parts of the machine, including main bearings, cranks, cylinders and wrist pin, so that the machine requires no attention, and does away with the necessity of putting oil into the cylinder with its objectionable feature of forcing oil gas into the mine.

These machines are strictly first-class in every detail of design, material and workmanship, and the different sizes give ample air to run the drills specified.

RISDON AIR COMPRESSORS.

No. of Compressor.	Diam. of Cylinder.	R. P. M.	No. of "D" or 3 5-6 Inch Drills, for which Comp. will give plenty of air at revolutions given.	No. of "A" or 2¼ Inch Drills, for which Comp. will give plenty of air at revolution given.
137	6½ x 8	150		1
138	8 x 10	150	1	2
139	10 x 10	150		3
140	11 x 12	150	2	5

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Belt or Water Wheel Compressor for Small Plants.

Sizes Page 40.

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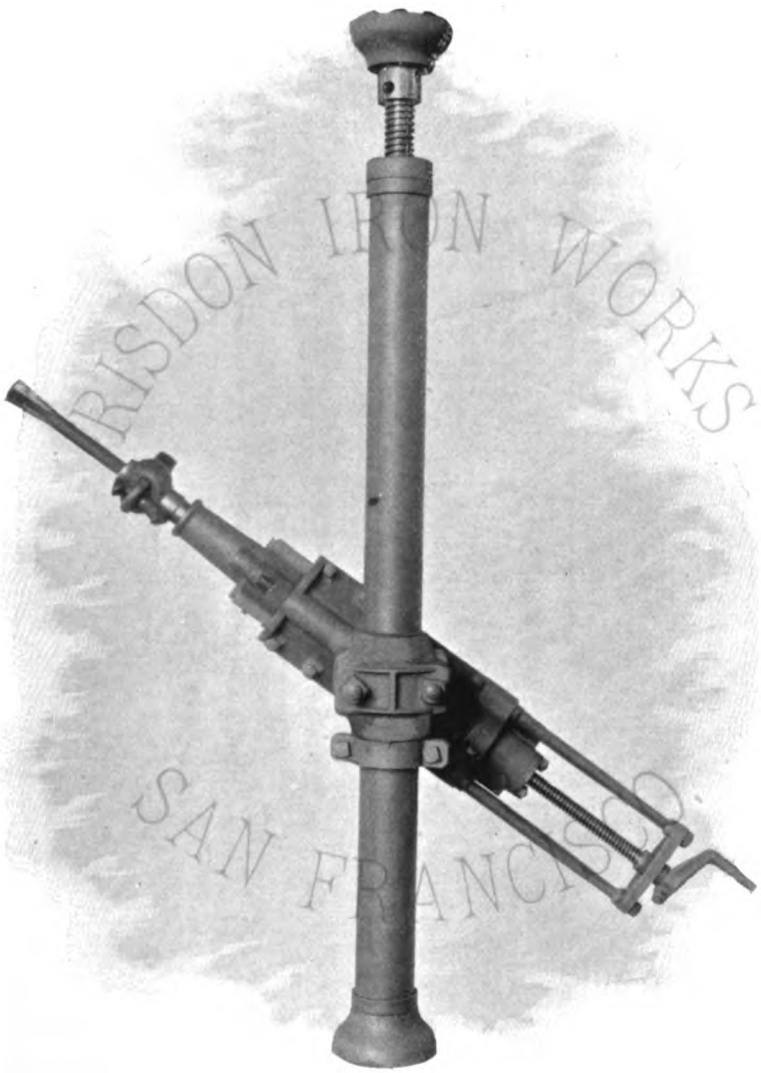
RISDON AIR DRILLS

The "RISDON" IMPROVED DRILLING MACHINE is the outcome of a series of carefully conducted experiments covering a period of five years. During this time all of the leading American and European makes of Rock Drilling Machines were carefully examined, their good points being fully appreciated, while their weaknesses were specially noted. The motive prompting this investigation was the desire to perfect a Rock Drilling Machine that would be specially adapted to meet the severe requirements in drilling the hard rock encountered in the mines on the Pacific Coast.

During their investigation special attention was given to the opinion of the users of Drilling Machines, their experiences being considered an excellent guide in not only appreciating what was required of "The Ideal Drilling Machine," but in also selecting the desirable features of the several leading types of machines at present in the market, but principally to learn of their defects and weaknesses so as in designing the "Risdon" Machine to eliminate these defects as far as possible.

These investigations not only considered the points just mentioned, but also included the designing and making of a number of machines, these machines being fully tested in the Works, and their apparent objections and weaknesses reminded, and then an extensive test at actual mining work. As soon as any defect developed, the machine was returned to the Works, and the defect located and overcome. The result of these very careful experiments has been the development of a drilling machine which is designed and built on the proper lines, and which is the simplest, most durable and economical machine on the market—in fact being a matter of evolution—"The Survival of the Fittest."

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Risdon Improved Air or Steam Rock Drill.

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Continued from page 42.

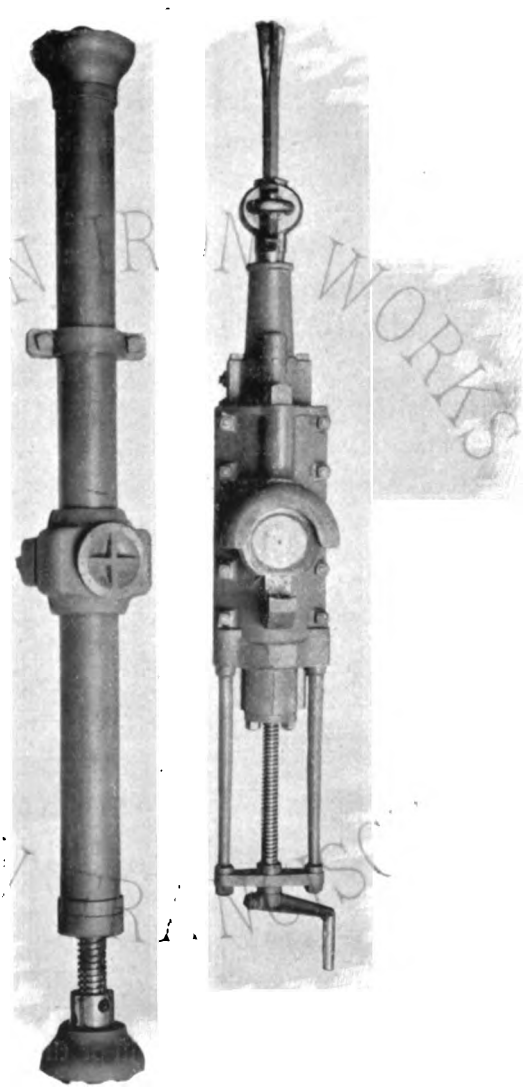
In designing this machine the following requirements of a good Rock Drill, taken from the work of Andre on "Coal Mining," were carefully considered, viz.:

1. A machine rock drill should be simple in construction and strong in every part;
2. It should consist of few parts, and especially of few moving parts;
3. It should be as light in weight as can be made consistent with the first condition;
4. It should occupy but little space;
5. The striking part should be of relatively great weight, and should strike the rock directly;
6. No other part than the piston should be exposed to violent shocks;
7. The piston should be capable of working with a variable length of stroke;
8. The sudden revoval of the resistance should not be liable to cause an injury to any part;
9. The rotary motion of the drill should take place automatically.

The following description, with the aid of the illustration, will be of assistance in appreciating the many points of merit of this machine:

WEARING PARTS.—The machine is simple in every part, and is entirely free from cams or tappets of any description—in fact it consists of only *two quick moving parts*, the piston and valve, and these, as well as other parts, are very substantial. In the D size machine the *Piston Rod is 2 1-4 inches Diam.*, whereas in other makes of machines of this size the Piston Rods are only 1⅝ inches and 1¾ inches in diameter. This heavy Piston Rod has many advantages, especially in drilling through seamy ground or through extremely hard rock where there is a heavy, racking strain on the piston.

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Risdon Improved Rock Drill With Column and Clamp.

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Continued from page 44.

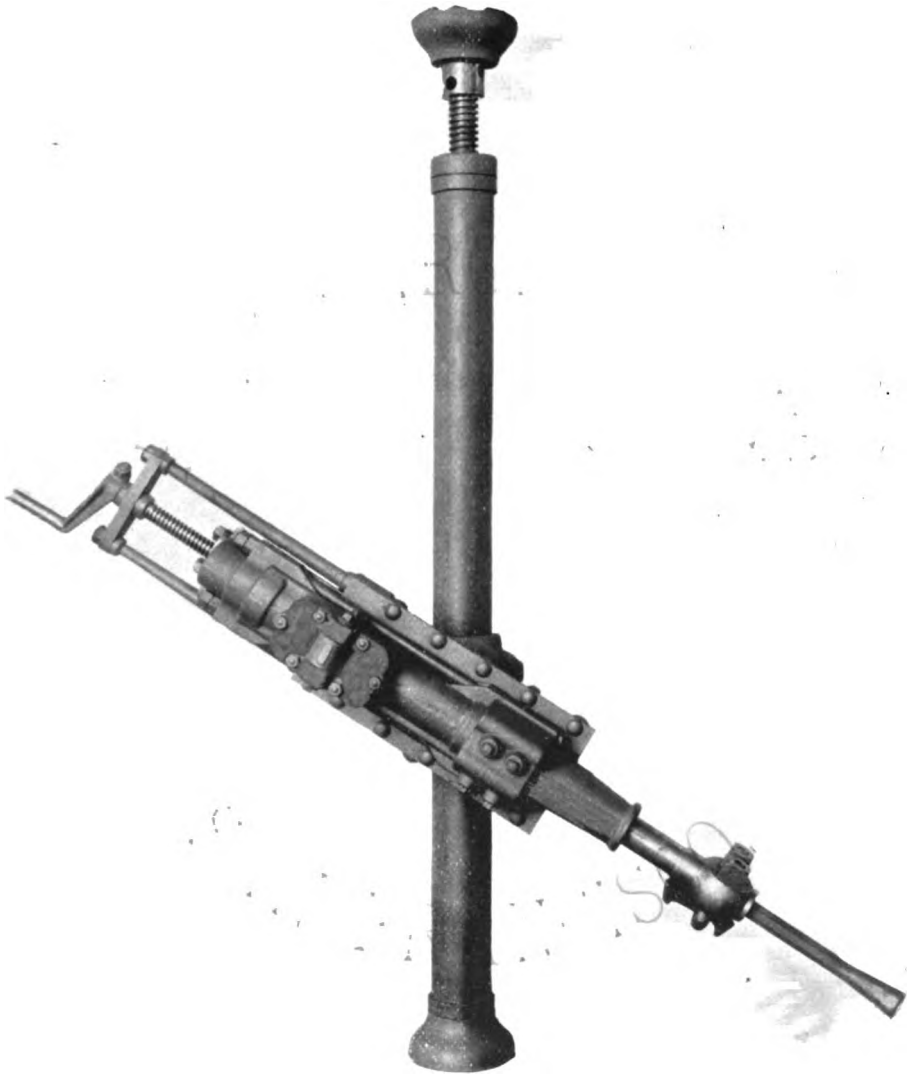
PERFORMANCE—This has been recently demonstrated in driving a tunnel near Waterford, on the Tuolumne River, which was being driven through a serpentine and flint deposit—being the hardest rock in California. In starting this work drills of one of the leading makers were used, but owing to the extreme hardness of the rock, these machines were a continual source of annoyance and expense, as the piston rods would break off, and the machines were in the shop for repairs the greater part of the time.

A "Risdon" machine was then put in this tunnel, and has been in continuous service (at the time of writing) for over four months without any repairs whatsoever, the air pressure used being 100 to 120 lbs. per square inch, and the "Risdon" Drill is regularly averaging 10 and 12 holes, 5 feet deep, per shift, in this rock.

VALVE—The valve is a small, very light, balanced valve, entirely independent of the piston, and does not move until the blow has been struck—making this, in reality, a "Dead Stroke Drill" (without any cushion whatsoever). The valve is in reality perfect, and does not wear; some of these, after having been in constant heavy use for more than a year, have been compared with the original gauges and were up to the original dimensions, showing that no wear had taken place, which is an essential feature in drilling machines.

CHANGE OF STROKE—Owing to the independent valve arrangement, the *Piston has a variable stroke*, and will operate perfectly from *half stroke to full stroke*. This it a great advantage in starting a hole, as the machine need only be brought up close to the work by turning the feed-screw crank, and then when the hole is well started can be drawn back to full stroke; this saves one half the time in starting a hole over that required by a drill of the tappet type that will operate

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Risdon Improved Rock Drill and Column.

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Continued from page 46.

only at about full stroke. Another advantage of the variable stroke is that it enables the drill to work in seamy or broken holes.

PISTON.—In this drill the piston is the only part subjected to violent shocks; and as it is so much heavier than is usual in standard practice, it withstands this duty without any difficulty. In addition, owing to the superior guide formed by the solid front head, and the design of the piston, it does not bring excessive wear on the drill cylinder, which shows apparently no wear after long and severe service.

BACKING.—The drill has a backing power, a recovery equal to its blow, which is of the greatest importance in preventing the drill bit sticking in seamy or broken ground. In this respect the "Risdon" Drill is very much more powerful than any other machine.

ROTATING MOTION.—The rotary motion is in the front head, and is applied direct to the piston rod in such a manner as to make a most substantial arrangement, and is entirely different from other machines which use a hollow piston rod and depend upon a frail rifle bar to turn the piston; whereas in the "Risdon" Drill the large piston rod itself takes the place of the rifle bar, and the rotary nut is made of a special bronze, and is prevented from turning back by two tempered steel pawls 4 inches wide. This part of the machine is one of its greatest points of advantage over any other machine.

CUSHIONING.—The piston is cushioned on its return stroke by a novel air cushion which takes the place of rubber bumpers or steel springs, and most successfully checks the return stroke of the piston; and, in addition, the energy expended in compressing the air in the cushion is given out again in useful work in driving the piston on its forward or drilling stroke. This feature adds materially to the rapidity and force of the striking blows.

CONVENIENT.—The machine is most convenient in all its details. To

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RISDON DRILLS

SIZE D, SERIES G.

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remove the machine from the column, tripod or quarry bar it is only necessary to slacken one nut, it not being necessary to remove a nut or bolt; and, owing to the special design of the shell, the nut clamping the machine to the column, tripod or quarry bar is always in a most convenient position for the chuck tender, i.e., at the front end of the machine. This clamping device is worthy of more than passing notice; its simplicity and convenience, as well as its positive holding qualities, are admired by all mining men of experience.

CHUCK—The device for holding the drill steel in the piston is an arrangement that has given excellent results. In addition to the V bolt and nuts, a tapered gib or key with heads at each end, is inserted between the chuch block and under the V bolt. To clamp the drill steel it is only necessary to drive forward this key; to release the drill steel, drive back the key. This saves much time in changing drill bits, and also prevents the breaking of V bolts. It has a further advantage, in that it prevents the drill steel jarring loose in the piston, as the tendency is for the key to be driven up tighter by the striking of the bit on the rock.

DUPLICATE PARTS—All parts of these machines are made with special machinery, and are made to standard gauges, which insure perfect accuracy of interchange of parts.

MATERIAL AND PATENTS—The material used is absolutely the best for the purpose for which it is used, and the workmanship is of the highest class. The many points of merit of the "Risdon" Machines are fully covered by Letters Patent of the United States, and by Patents pending.

CONSUMPTION OF AIR—Owing to there being no long air passages in this machine, as in other machines, which require to be filled, each stroke with air that gives out no useful work, the consumption of air is less for the actual work done than in any other machine. The strokes are also much more rapid, for the same reason.

DRILLS—All our drills use Octagon Steel, without any blacksmith work on chuck ends.

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Risdon Improved Rock Drills

SPECIFICATIONS

LETTER INDICATING SIZE	A	D
Diameter of Cylinder	2¼ in.	3 5-16 in.
Length of Stroke	5 in.	7 in.
Size of Air Hose	¾ in.	1 in.
Weight of Drill unmounted	128 lbs.	285 lbs.
Approximate strokes per minute with 60 lbs. pressure at Drill	700	500
Depth drilled without changing Bits	17 in.	24 in.
Depth of vertical hole each machine will easily drill	5 ft.	14 ft
Diameter of holes Drilled	1 to 1 5/8 in.	1¼ to 2½ in.
Size of Steel used	⅞ oct.	1⅛ oct.
Size of shanks	⅞ oct.	1⅛ oct.
No. of Drills per set to drill to depth given	5	8
Approximate weight of one set to drill vertical holes of depth given	44 lbs.	241 lbs.
Horse Power of Boilers required to run by Steam direct	5 H. P.	10 H. P.
Size of Pipe required for 100 to 200 feet	¾	1

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Price List "Risdon" Drills

LETTER INDICATING SIZE	A	D
Price of Drill, Unmounted, without tripod or column	$170.00	$275.00
Price of adjustable tripod, complete	30.00	40.00
Price of Single Screw Shaft or Tunnel Bar, *with* clamp, 6 to 8 feet long	30.00	40.00
Price of Double Screw Tunnel Bar, *without* clamp and arm, 6 to 8 feet long, for D drill only		28.00
Clamp for Tunnel Bar		13.00
Adjustable Arm Tunnel Bar		16.00
Quarry Bar for Gadding, Channeling, etc	175.00	250.00
Set of 5 Blacksmith's Tools for Dressing and Machining Drill Bits	7.50	10.00
50 feet Best Guaranteed Flat Steel Armored 5-ply Hose, complete with Doble Perfected Couplings	33.00	37.00

Send for Discounts

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DRILL STEEL

PRICE LIST

A. MACHINE.

⅞ OCT. DRILL STEEL.				PRICE.		
Depth of Hole Drilled by each Set of Steels.			No. of Steels in Set.	American.	Manganese.	Firth's Best English
Pounds	Ft.	In.				
4¼	1	6	1	$ 1.75	$ 1.95	$ 2.25
10½	2	6	2	3.65	4.20	4.95
20	3	4	3	5.75	6.75	8.90
30	4	6	4	8.00	10.20	12.40
44	5	6	5	10.40	13.20	16.65

D. MACHINE.

1⅛ OCT. STEEL.						
9½	2	0	1	2.50	3.00	3.70
24½	3	6	2	5.40	6.75	8.60
45	5	0	3	8.75	11.30	14.50
71	6	6	4	12.50	16.50	21.50
103	8	0	5	16.50	22.50	29.60
141	10	0	6	21.50	29.50	39.50
188	12	0	7	26.50	37.50	50.50
241	14	0	8	32.50	46.50	62.90

This length is in addition to Shank.

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Directions for Operating Risdon Rock Drills

Care must be taken to have the mountings secure and firm ; this cannot be looked after too carefully.

In setting a column use a piece of plank several inches thick (4 to 6 inches), about 2 feet 6 inches long by 9 to 12 inches wide on the bottom of heading or tunnel; place the cups on this plank, set the points of jack screws in same, straighten column, putting a piece of plank on head of same, fill in the space between roof and head with blocks and wedges, so that when the jack screws are tightened the head board will bear evenly on head of column; next place safety clamp on column at proper height, then place arm on top of safety clamp, then attach drill clamp or chuck to arm, then mount drill in chuck, and after putting in starting bit and setting drill in proper position for hole, tighten all bolts firmly, especially arm and clamp bolts.

In starting a hole in an oblique surface, time will be saved by spawling off a spot large enough to allow the bit to start straight on a flat surface, otherwise the sharp cutting corner of bit will be worn off, permitting bit to glance, thus throwing unnecessary strain on the machine without any compensating gain.

In setting a shaft bar use planking at both ends, well wedged and leveled up. Attach main clamp and drill direct to shaft bar without using arm.

In setting tripod it is well to sink holes for points of same with a gad from ½ inch to ¾ inch, so they will not slip.

To change drill from right to left side, or vice versa, on tunnel column, move main clamp to end of arm, loosen set nut and arm bolts, thereby permitting turning of drill in chuck.

If necessary to drill lower or bottom holes very flat turn drill under arm, as the Risdon Drill will work equally well bottom side up, or in any other position.

In starting holes, feed machine up so as to shorten stroke to 2 or 3 inches as nature of rock and shape of face may require; this gives a short light, blow, making the starting of a hole easy and quick. Drill runners will appreciate this point, which is a feature peculiar to this drill.

KEEP THE MACHINE WELL OILED, particularly a new one, which should be oiled while running at least every half hour the first few days.

Keep piston rod well oiled, so that friction in stuffing box may be reduced to a minimum. Oil should be applied in front of stuffing box in small quantities and at short intervals.

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Oil piston and valve at a point between throttle valve and main valve of drill. When oil is so applied the air or steam carries it through the machine, lubricating all the inner working parts more thoroughly than can be done in any other way.

Oil should be put in the back head occasionally, that it may more thoroughly lubricate the rotating mechanism.

DO NOT USE BLACK OIL OR CYLINDER OIL when using compressed air as power, but a light engine oil, or what is STILL BETTER, OUR AIR DRILL OIL, prepared especially for this purpose.

When using steam for power use best cylinder oil.

NEVER USE VEGETABLE OR ANIMAL OIL UNDER ANY CONSIDERATION if it can possibly be avoided.

Wipe off shank of drill, and be sure that it rests firmly in bottom of chuck before tightening chuck bolts. Chuck bolts should be tightened thoroughly and evenly. It is a common practice among many drill runners to tighten one chuck bolt nut before tightening the other. This is wrong and will surely result in an unnecessary number of broken chuck bolts.

The Risdon Drills are all thoroughly tested before shipment, and the parts are fitted closely; for this reason the drill may work a little stiff for the first few days. Should this be the case, pay particular attention to directions for oiling.

The feeding of the drill depends upon the speed with which the bit cuts into the rock; if fed too fast the stroke is shortened; if fed too slow the piston will strike the front head or buffer; in either case the machine is expending its power upon itself instead of upon the rock, so that the proper feeding is necessary to get the best results from a drill.

The proper feeding of a drill can only be acquired by experience and close attention on the part of the operator. The machine should be fed just fast enough to give the piston very nearly its full stroke, except when starting a hole or crossing a seam or seamy spot in the rock.

The best drill runner is the one that not only knows how to put in holes, but who takes care of his machine, and on the drill runner to a large extent depends the size of the repair bill. If a drill runner will watch his machine, keep it oiled, and if a nut or bolt gets loose attend to it at once, he will frequently save a break-down.

The main qualifications of a good drill runner are judgment and experience; he must be a careful man, of patience and energy. A careless, shiftless man is an expensive man to put in charge of a drill, no matter what his experience may have been.

It is always best to put some one in charge of the drills who has had some experience and knows something of their uses. However, satisfactory drill runners can usually be made by taking bright, intelligent men from the mine and letting them work for a few days with some thoroughly reliable man.

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Specifications for a Complete Plant to Operate One of Our Standard $3\frac{5}{16}$-inch Rock Drills by Compressed Air

---

1 Risdon Improved Air Compressor, complete with improved water circulating jacketed cylinder and heads, automatic sight feed lubricator on both air and steam cylinders, improved unloading device; all oil cups and foundation bolts and washers. Capacity of compressor sufficient to run one of our standard $3\frac{5}{16}$-inch cylinder rock drills.

1 Steel Air Receiver, diameter 30 inches, length 72 inches, furnished complete with manhead, pressure gauge, pop safety valve and blow-off cock.

1 Of our standard $3\frac{5}{16}$-inch cylinder rock drills complete with valves and wrenches (unmounted).

1 Improved double screw tunnel column complete with arm, clamp, safety clamp, cups and wrenches.

1 Length, (50 ft.,) of 1-inch wire-wound air hose with Risdon improved couplings.

1 Set of blacksmith tools for sharpening drill bits, including 1 dolly, $1\frac{1}{4}$ dolly, 1 sow, 1 spreader, 1 flatter, 1 swage.

1 Set of fitted steels for drilling holes to a depth of 8 feet, including 6 steels with bits and shanks.

1 20 Horse-Power vertical tubular boiler complete with grate bars, bearing bars, smokestack, steam gauge gauge cocks, glass water gauge, safety valve and all fittings, including injector.

Pipe and fittings to connect boiler with compressor and compressor with receiver, including valves and pipes.

Approximate cost of above, depending on style of compressor, $1500.

Send for discounts.

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Specifications for a Complete Plant to Operate Two of Our Standard $3\frac{5}{16}$-inch Rock Drills by Compressed Air

---

1 Risdon Improved Air Compressor, complete with improved water circulating jacketed cylinder and heads, automatic sight feed lubricator on both air and steam cylinders, improved unloading device; all oil cups and foundation bolts and washers. Capacity of compressor sufficient to run two of our standard $3\frac{5}{16}$-inch cylinder rock drills.

1 Steel Air Receiver, diameter 36 inches, length 72 inches, furnished complete with manhead, pressure gauge, pop safety valve and blow-off cock.

2 Of our standard $3\frac{5}{16}$-inch cylinder rock drills complete with valves and wrenches (unmounted).

2 Improved double screw tunnel columns complete with arm, clamp, safety clamp, cups and wrenches.

2 Length (50 ft.,) of 1-inch wire-wound air hose with Risdon improved couplings.

1 Set of blacksmith tools for sharpening drill bits, including 1 dolly, $1\frac{1}{4}$ dolly, 1 sow, 1 spreader, 1 flatter, 1 swage.

2 Sets of fitted drill steels for drilling holes to a depth of 8 feet, including 6 steels with bits and shanks.

1 30 Horse-Power vertical or horizontal tubular boiler complete with grate bars, bearing bars, smokestack, steam gauge, gauge cocks, glass water gauge, safety valve and all fittings, including injector.

Pipe and fitting to connect boiler with compressor and compressor with receiver, including valves and pipes.

Approximate cost of above, depending on style of compressor, $2500.

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Specifications for a Complete Plant to Operate Three of Our Standard $3\frac{5}{16}$-inch Cylinder Rock Drills by Compressed Air

---

1 Risdon Improved Air Compressor, complete with improved water circulating jacketed cylinder and heads, with automatic sight feed lubricators on both air and steam cylinders, improved unloading device, all oil cups and foundation bolts and washers. Capacity of compressor sufficient to run three of our standard $3\frac{5}{16}$-inch cylinder rock drills.

1 Steel Air Receiver, diameter 36 inches, length 96 inches, furnished complete with manhead, pressure gauge, pop safety valve and blow-off cock.

3 Of our standard $3\frac{5}{16}$-inch cylinder rock drills complete with valves and wrenches (unmounted).

3 Improved double screw tunnel columns complete with arms, clamps, safety clamps, cups and wrenches.

3 Lengths (50 feet each) of 1-inch wire-wound air hose with Risdon improved couplings.

1 Set of blacksmith tools for sharpening drill bits, including 1 dolly, $1\frac{1}{4}$ dolly, 1 sow, 1 spreader, 1 flatter, 1 swage.

3 Sets of fitted drill steels for drilling holes to a depth of 8 feet (6 steels in set with bits and shanks).

1 40 Horse-Power tubular boiler complete with half-arch front, grate bars, bearing bars, steam gauge, glass water gauge, gauge cocks, safety valve, smokestack, and all fittings, including injector.

Pipe and fittings to connect boiler with compressor, and compressor with receiver, including valves and pipes.

Approximate cost of above, depending on style of compressor, $3500.

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Specifications for a Complete Plant to Operate Five of Our Standard 3 5/16-inch Cylinder Rock Drills by Compressed Air

1 Improved Air Compressor, with improved water circulating jacketed cylinder, automatic sight feed lubricators on both air and steam cylinders, improved unloading device, Risdon automatic regulator for controlling pressure on steam cylinder, all oil cups and foundation bolts and washers. Capacity of compressor sufficient to run 5 of our standard 3 5/16-inch cylinder rock drills.

1 Steel Air Receiver, diameter 42 inches, length 96 inches, furnished complete with manhead, pressure gauge, pop safety valve and blow-off cock.

5 Of our standard 3-inch cylinder rock drills, complete with valves and wrenches (unmounted).

5 Improved double screw tunnel columns, complete with arms, clamps, safety clamps, cup and wrenches.

5 Lengths (50 feet each) of 1-inch wire-wound air hose with Risdon improved couplings.

1 Set of blacksmith tools for sharpening drill bits, including 1 dolly, 1 1/4 dolly, 1 sow, 1 spreader, 1 flatter, 1 swage.

5 Sets of fitted drill steels for drilling holes to a depth of 8 feet (6 steels in set with bits and shanks).

1 80 Horse-Power tubular boiler complete with half-arch front, grate bars, bearing bars, steam gauge, glass water gauge, gauge cocks, safety valve, smokestack, and all fittings, including injector.

Pipe and fittings to connect boiler with compressor, and compressor with receiver, including valves and pipes.

Approximate cost of above, depending on style of compressor, $6000.

Send for discounts.

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LIST

—OF—

Parts of Series G, Size D, Air Drill

		Pieces
1.	Cylinder	1
2.	Back Head	1
3.	Front Head	1
4.	Bonnet	1
5.	Shell	1
6.	Body of Clamp	1
7.	Cap for Clamp	1
8.	Cylinder Extension	1
9.	Bolts in Clamp	2
10.	Washers for Clamp Bolts	2
11.	Nuts for Clamp Bolts	2
12.	Piston Rod	1
13.	Front Piston	1
14.	Back Piston	1
15.	Key for Front Piston	1
16.	Key for Back Piston	1
17.	Front Piston Ring	1
18.	Back Piston Ring	1
19.	Valve	1
20.	Buffer Plates	2
21.	Cylinder Studs	6
22.	Cylinder Tie Bolts, 2 nuts	2
23.	Feed Screw	1
24.	Feed Screw Nut	1
25.	Bolts for Feed Screw Nut	2
26.	Guard for Feed Screw	1
27.	Ratchet	1
28.	Ratchet Pawls	2
29.	Plugs in Front Head	4
30.	Pawl Springs	4
31.	Inlet and Outlet Plugs	4
32.	Round Bushing for Head	1
33.	Octagon Bushing for Head	1
34.	Chuck Blocks	1
35.	U Bolt	1
36.	Nuts for U Bolt	2
37.	Guide Ring	1
38.	Crank Handle for Feed Screw	1
39.	Throat Bushing	1
40.	Rubber Bumpers for Valves	2
41.	Guides for Shell	2
42.	Bolts for Shell Guides	10
43.	Struts for Yoke	2
44.	Yoke	1
45.	Bolt for Feed Handle	1
46.	Wrench for Drill Chuck	1
47.	Washer for Rubber Bumper	1
48.	Rubber Bumper	1
49.	Ring Bolt in Shell	1
50.	Stud Wrench	1
51.	Wrench for Tie Bolts	1
52.	Key for U Bolt	1
53.	Oil Plug in Front Head	1
54.	Pins for Struts in Shell	2
55.	Nut for King Bolt	1

Same Numbers used for "A" Drill.

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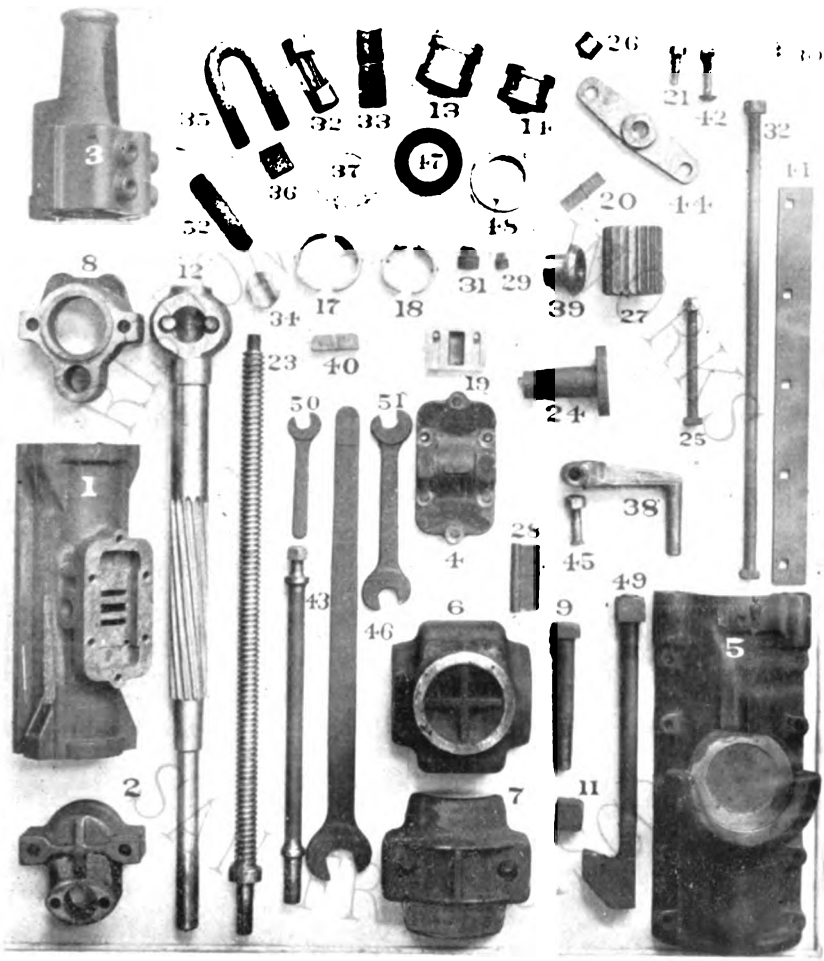


ILLUSTRATION OF PARTS

RISDON DRILLS

SIZE D., SERIES G.

Same numbers used for "A" drill.

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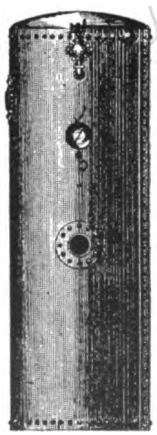
Air Receivers and Pressure Tanks

For 110 Pounds Working Pressure

Made of best 60,000 pounds t. s. Steel, side seams double riveted; strongly made with dished heads, and tested up to 165 pounds water pressure; warranted safe and tight under 110 pounds working pressure. Fixtures will include manhead, safety valve pressure gauge, drain cocks, and flanges for inlet and discharge pipes.

NO. OF SIZE.	1	2	3	4	5	6	7	8
Diameter . . . . . inches,	30	36	36	42	42	48	54	66
Length, ... feet,	6	6	8	8	10	12	12	18
Thickness of Shell . inches,	¼	¼	¼	1	¼	9-32	5-16	⅜
Thickness of Heads, "	5-16	⅜	⅜	⅜	⅜	7-16	7-16	½
Weight about . . . . . lbs.	1000	1300	1600	1900	2200	3300	4200	5500
Diameter of Safety Valve . in.	1½	1½	1½	2	2	2½	2½	3
Diameter of Inlet and Discharge Flanges	2½	3	3½	3½	4	5	6	8
No. of 3⅛ inch Drills Receiver is best adapted for . .	1	2	3	5	8	12	20	35
Compressor capacity Receiver is best adapted for (cubic feet free air per minute)	150 or less	150 to 200	200 to 300	300 to 500	500 to 700	700 to 1,200	1,200 to 3,000	3,000 and over
Price, f. o. b. factory complete.								

The illustration below shows an air receiver suitable for machine shops, granite yards, and all places where a small air compressor is used. It is made of the best steel, single riveted, tested to 165 pounds water pressure. Warranted safe and tight under 110 pounds working pressure. Fixtures include safety valve pressure gauge, drain cocks, and tap for inlet and discharge pipes.



NO. OF SIZE.		
Diameter, ... inches,	18	24
Length, ... feet,	6	6
Thickness of Shell, . inches,	11-64	3-16
Thickness of Heads, . "	¼	¼
Weight about . . . . lbs.	250	350
Diameter or Safety Valve, . in.	1	1¼
Diameter of inlet and Discharge, ... inches,	2½	2½
No. of 2½ inch Drills receiver is best adapted for, . .	1	2
Compressor capacity receiver is best adapted for (cubic feet free air per minute), .	90	120
Price, f. o. b. factory complete.		

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Compressed Air for Rock Drills and Coal Cutters

The following table is intended to show at a glance the *approximate* quantity or volume of free air required for operating Rock Drills and Coal Cutters, the air being delivered to the machines at 60 lbs. pressure.

As applied to Rock Drills, these figures are necessarily approximate only, owing to the varying conditions under which each w.rk is performed; but they will be found to apply closely to average conditions in rock of moderate hardness. A liberal allowance has been made above the actual requirements of new machines, to provide for wear, etc., but of course no allowance is made for leaky pipe, as this should not be permitted to exist. In soft material the actual drilling time is short, and more drills can be run with a given size compressor than where the material is hard and the drills running continuously for a longer period, thereby increasing the chance of all the drills drawing on the compressor at the same time.

In tunnel work in hard rock, where a high air pressure is carried to insure rapid progress, experienced contractors have found it profitable to provide compressor capacity in excess of the usual requirements by 25 to 50 per cent.

As applied to Coal Cutters, the figures given are liberal, and more machines can probably be added where a large plant is in operation; but it should always be remembered that it is better economy to provide a large compressor and run it slowly, rather than a smaller one that has to be driven to its full capacity. This fact is recognized by the best engineers, and it applies more particularly to a compressor than to an engine or boiler.

The capacities in this table are based on *60 pounds air pressure;* if 75 pounds is used, one-fifth more volume should be added; if 90 pounds, two-fifths should be added to the volume stated in the table.

TABLE SHOWING CUBIC FEET OF FREE AIR REQUIRED TO RUN FROM ONE TO FORTY MACHINES WITH SIXTY POUNDS PRESSURE

Number of Machines.	ROCK DRILLS. Size Cylinders		COAL CUTTERS. Size Cylinders	
	2¼ inch	3 5-16 inch	3¼ inch	4 inch
1	65	115	70	93
2	110	200	140	186
3	156	294	210	279
4	196	372	280	372
5	230	445	350	465
6	264	516	420	558
7	294	581	490	651
8	320	640	560	744
9	360	720	630	837
10	400	800	700	930
12	480	960	840	1116
15	.....	1200	1050	1395
20	.....	1600	1400	1860
25	.....	2000	1750	2325
30	.....	2400	2100	2790
40	.....	3200	2800	3720

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CAPACITY OF COMPRESSORS

It is a common practice to multiply the area of the air piston by the distance it travels in a minute, and to state the product as the free air capacity of the Compressor. To ascertain the bulk of the air in compressed form, it is necessary to add 15 lbs. to the gauge pressure, and divide the amount by 15. The result will be the number of atmospheres in the air of that pressure. The free air capacity of the Compressor divided by the number of atmospheres will give the amount of air after compression. This amount must be reduced by allowances of various kinds. The losses due to poor designing and workmanship, the use of warm induction air, insufficient supply, losses in clearance and leaks, may be quite serious. In some machines these losses amount to a clear thirty per cent. of their theoretical capacity, whereas ten per cent. should be liberal for all ordinary contingencies. There must, however, be an allowance made in the capacity of all Compressors by reason of their heights above the sea level. At an elevation the air is not so dense as at the sea level, and hence at each revolution the Compressor will take in a less weight of air and be able to do less work. To make exact comparisons of efficiency it is necessary to know whether the compressed air is used expansively or at full stroke, or whether the actual work done is to be compared. Generally speaking, the Compressor will run with less power at the elevation than at the lower level, but its capacity in the amount of compressed air produced will be so much less, that as a net result more power is used to do the same work at a height than at the sea level.

As it is a very common practice to use air in drills and like machines at full stroke, we append a table of efficiencies of Compressors when the air is so used at 60 lbs. per square inch gauge pressure, and at various heights above sea level.

Height in Feet above Sea Level.	Barometer.	Efficiency of Compressor.
0	30 inches	100.0 per cent.
500	29.42 "	98.4 "
1,000	28.85 "	96.9 "
1,500	28 34 "	95.5 "
2,000	27.78 "	94.0 "
3,000	26.74 "	91.1 "
4,000	25.70 "	88.1 "
5,000	24 73 "	85.9 "
6,000	23.83 "	82.8 "
7,000	22.93 "	80.2 "
8,000	22.04 "	77.5 "
9,000	21.22 "	75.1 "
10,000	20.43 "	72.7 "
12,000	18.92 "	68.0 "

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Capacity of Air Cylinders for 100 Feet Piston Speed, at 100 Per Cent Volumetric Capacity.

DIAMETER OF CYLINDER.	Free	10 lbs.	20 lbs.	30 lbs.	40 lbs.	50 lbs.	60 lbs.	70 lbs.	80 lbs.	90 lbs.	100 lbs.
	1.00	.595	.423	.329	.268	.227	.196	.173	.155	.140	.127
8 in.	34.91	20.76	14.78	11.48	9.38	7.93	6.86	6.04	5.41	4.89	4.43
10	54.54	32.45	23.10	17.94	14.66	12.39	10.72	9.45	8.46	7.65	6.92
12	78.54	46.73	33.26	25.83	21.11	17.85	15.44	13.61	11.18	11.02	9.97
14	106.92	63.61	45.28	35.17	28.73	24.29	21.02	18.52	16.59	15.00	13.57
16	139.64	83.08	59.14	45.93	37.52	31.73	27.46	24.19	21.66	19.60	17.73
18	176.72	105.14	74.85	58.13	47.49	40.16	34.75	30.62	27.42	24.81	22.44
20	218.16	129.81	92.41	71.77	58.64	49.58	42.91	37.80	33.85	30.62	27.70
24	314.16	186.93	133.07	103.35	84.44	71.40	61.79	54.44	48.75	44.10	39.89
30	490.87	292.08	207.92	161.49	131.94	111.57	96.55	85.06	76.18	68.91	62.34
36	706.88	420.60	299.41	232.55	190.00	160.66	139.03	122.49	109.70	99.24	89.77

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Table Showing Cubic Feet of Free Air Compressed and Delivered Per Minute Per I. H. P., at Various Gauge Pressures, with Air at 60° Fah. and at Sea Level.

RECEIVER GAUGE PRESSURE.	Method of Compression.			
	Adiabatic.	Single Stage Jacktd. Cyl.	Double Stage Jacktd. Cyl.	Isothermal.
10	28.0	28.2	28.7	30.3
20	16.0	16.3	16.8	18.2
30	12.0	12.2	12.6	14.1
40	9.8	10.0	10.5	11.9
50	8.5	8.7	9.2	10.5
60	7.5	7.7	8.2	9.6
70	6.8	7.	7.5	8.9
80	6.36	6.6	7.0	8.4
90	5.9	6.2	6.5	8.0
100	5.6	5.8	6.2	7.6
125	4.94	5.1	5.6	6.9
150	4.5	4.7	5.07	6.45

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Table Showing I. H. P. Required to Compress and Deliver 100 Cubic Feet of Free Air Per Minute at Various Pressures, 60° Fah. and Sea Level.

RECEIVER GAUGE PRESSURE.	Method of Compression.			
	Adiabatic.	Single Stage Jacktd. Cyl.	Double Stage Jacktd. Cyl.	Isothermal.
10	3.57	3.55	3.48	3.3
20	6.22	6.14	5.95	5.5
30	8.33	8.21	7.91	7.1
40	10.21	9.96	9.48	8.4
50	11.73	11.46	10.87	9.5
60	13.25	12.84	12.2	10.4
70	14.67	14.07	13.25	11.2
80	15.72	15.18	14.27	11.9
90	16.88	16.22	15.29	12.6
100	17.83	17.2	16.06	13.2
125	20.21	19.33	18.03	14.4
150	22.31	21.22	19.72	15.5

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Loss of Pressure Through Friction of Air in Pipes

For Every 100 Feet Length of Pipe (Initial Gauge Pressure 80 lbs. at Receiver)

Equivalent Volume of Free Air Discharge per minute.	SIZE OF PIPE IN INCHES.													
	1	1¼	1½	2	2½	3	4	5	6	7	8	10	12	14
25	.24	.12												
50	1.00	.45	.18											
75	2.4	1.0	.4											
100	.....	1.7	.70	.13										
200	.....	.....	3.00	.50	.175									
300	.....	.....	.....	1.20	.38	.15								
400	.....	.....	.....	2.15	.67	.27	.06							
500	.....	.....	.....	3.30	1.10	.40	.10	.03	.012					
750	.....	.....	.....	.....	2.50	.91	.22	.07	.03	.013				
1000	.....	.....	.....	.....	.....	1.8	.40	.12	.05	.023	.012			
1500	.....	.....	.....	.....	.....	4.00	1.00	.30	.12	.052	.027			
2000	.....	.....	.....	.....	.....	.....	1.60	.50	.20	.095	.048	.017		
3000	.....	.....	.....	.....	.....	.....	3.70	1.20	.45	.22	.115	.036	.015	
4000	.....	.....	.....	.....	.....	.....	.....	2.00	.80	.39	.20	.07	.026	.012
5000	.....	.....	.....	.....	.....	.....	.....	.....	1.30	.60	.30	.10	.041	.018
6000	.....	.....	.....	.....	.....	.....	.....	.....	1.9	.85	.43	.15	.06	.028
7500	.....	.....	.....	.....	.....	.....	.....	.....	3.00	1.40	.68	.22	.09	.04
10000	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.5	1.25	.40	.17	.075

EXAMPLE—An air compressor furnishes 1000 cubic feet of free air per minute at a pressure of 80 pounds per square inch in the receiver. If this air is used at the end of a 4-inch pipe 2000 feet long, the loss due to friction will be 20 x .4=8 pounds. If the same volume of air were supplied by the same compressor at the same pressure and passed through a 6-inch pipe 2000 feet long, the loss would be only .05 x 20=1 pound; thus illustrating the importance of using pipe of large diameter. Strictly speaking the loss of pressure is not directly proportional to the length; however, for all practical purposes it may be taken as such.

The foregoing table represents the loss by friction in the pipe. There is a further slight loss due to the friction of the air with itself at the mouth of the pipe when it leaves the receiver. Elbows and irregularities in pipe increase the friction above the figures given in the table.

AIR LEAKAGE

All leaks in compressors or valves, air receivers or pipe, should be strictly guarded against for the sake of economy in the running of compressed air and steam apparatus. Air leaks are fully as expensive as steam leaks, and should be as carefully stopped. Too many operators think that an air leak is of but little consequence, but it should never be allowed, save where needed for actual ventilation.

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TABLE FOR BRANCH PIPES

IT IS A COMMON IDEA that the carrying capacity of a pipe is in proportion to its internal area. This is, however, not correct. A pipe four feet in diameter has only four times the area of a pipe two feet in diameter, and yet the four feet pipe will carry 5.66 times as much fluid as the two feet pipe, under the same conditions of length and head. In other words a two feet pipe will carry 17.6 per cent. or nearly 18 per cent. as much as will a four feet pipe. This proportion of carrying capacity does not hold good for smaller pipes of the same proportionate diameter. A one foot pipe has only 16.6 per cent. of the carrying capacity of a pipe two feet in diameter, and a one inch pipe will carry only 14 per cent. as much as a 2 inch pipe.

THESE FEATURES have not to our knowledge been heretofore taken into consideration in tables prepared for equalizing pipes. The proper values are given in the table below. In this table the commercial or nominal size is given, but in our calculations we figured 1¼ inch pipe as 1.3 inches diameter, and 1½ inch pipe at 1.6 inches, as these are nearer the actual sizes.

THE SIZE OF PIPE is given in the horizontal line on top, and directly beneath is stated successively the proportion of its capacity that other pipes will carry. These other pipes are stated in the vertical column on the left.

For example a six inch pipe can have 15 per cent. of its capacity carried by a 3 inch pipe, 23 per cent. by a 3½ inch pipe, 34 per cent. by a 4 inch pipe, and a 24 inch pipe will carry 38 times as much as the 6 inch pipe.

IN TAKING BRANCHES from a main it is advisable that the sum of the percentages of the carrying capacities of the branches should be 100 per cent. or more. Referring again to a 6 inch main we see that if it be divided into two branches, one 4 inches and the other 5 inches, the carrying capacities of the branches would be respectively 34 and 63 per cent. of the 6 inch pipe. Thus provision is made for only 97 per cent. and there would be slight additional friction from the point of diversion of the branches. If the branches be made 4½ and 5 inches, the percentages are respectively 47 and 63, their sum 110 and, from the junction, the flow would be considerably more free than in the first case.

RELATIVE CARRYING CAPACITY OF PIPES FOR AIR.

	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	10	12	24
1	1.	.48	.27	.14	.07	.05										
1¼	2.1	1.	.55	.29	.16	.10	.06									
1½	3.7	1.8	1.	.53	.29	.18	.11	.08								
2	7.14	3.4	1.9	1.	.53	.33	.21	.14	.10							
2½	13.4	6.3	3.5	1.9	1.	.63	.40	.27	.20	.15						
3	21.4	10.3	5.7	3.	1.6	1.	.67	.43	.32	.23	.15					
3½		16.1	9.	4.7	2.5	1.5	1.	.68	.50	.38	.23	.15				
4			13.1	6.9	3.7	2.3	1.4	1.	.71	.56	.34	.23	.15			
4½				9.6	5.	3.1	2.	1.4	1.	.77	.47	.31	.21	.12		
5					6.7	4.4	2.6	1.8	1.3	1.	.63	.42	.28	.16	.10	
6						6.5	4.3	2.9	2.1	1.6	1.	.66	.45	.26	.16	.03
7							6.5	4.4	3.2	2.4	1.5	1.	.71	40	.24	.04
8								6.5	4.7	3.5	2.2	1.4	1.	.59	.36	.06
10									8.3	6.3	3.9	2.5	1.7	1.	.61	.10
12										10.3	6.3	4.1	2.8	1.6	1.	.17
24											38.	24.	17.3	9.6	6.	1.

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Pumps Driven by Compressed Air

Relative Proportion of Areas of the Cylinders of the Pump. — Gauge Pressure of the Air, Cubic Feet Free Air for Each Gallon Water Raised.

Height of Water Column in Feet.	50	75	100	125	150	175	200	250	300	350	400	450	500
to 2	25. .40	37. .51	50. .65	62. .77	75. .90	87. 1.03							
2 to 1		18. .66	25. .80	31. .92	38. 1.06	43 1.15	50. 1.30	62. 1.54	75. 1.80	87. 2.04			
2½ to 1		15. .75	20. .8	25 .99	30. 1.13	35. 1.25	40. 1.37	50. 1.62	60. 1.87	70. 2.14	80. 2.38		
3 to 1			17. .95	21. 1.07	25. 1.19	29. 1.32	33. 1.45	42. 1.68	50. 1.95	58. 2.20	67. 2.44	75. 2 70	83. 2.92
3½ to 1			14. 1.02	18. 1.14	21. 1.37	25. 1.39	29. 1.52	36. 1.76	43. 2 03	50. 2.28	57. 2.51	64. 2.75	71. 3.00
4 to 1				15. 1.22	19. 1.34	22. 1.46	25. 1.58	31. 1.84	37. 2.09	44. 2.35	50. 2.59	56. 2.83	62. 3.08
5 to 1					15. 1.49	18. 1.60	20. 1.76	25. 1.98	30 2.27	35. 2.51	40. 2.73	45. 3.02	50. 3.24

Compressed air is largely used for driving Direct Acting Pumps in mines and at points distant from the power. In many cases these pumps are at first driven by steam, but as the work advances and the pump is moved forward, steam becomes powerless and also develops troublesome and unpleasant characteristics.

Compressed air does not condense; its exhaust is cool and the resulting ventilation most agreeable.

Any steam pump can readily be driven by air. It will move a little quicker under air than with steam of the same pressure, as the valve movements are not delayed by water of condensation.

For the reason that dry air will escape through an opening faster than wet steam which is loaded with water, it is advisable to see that the pump pistons and valves are in good condition when a change is made from steam to air power.

The above table gives the particulars relating to Pumps driven by air. The stated air presssure is the pressure in the pump driving the cylinder.

The proportion of cylinders is obtained by dividing the area of the air or driving cylinder by the area of the water cylinder.

A pump having an 8-inch air or steam cylinder and a 5-inch water cylinder is proportioned 2½ to 1. Such a pump, when raising water 175 feet through a short pipe of liberal area, will use 1.25 cubic feet of free air for each gallon of water pumped.

The easy capacity of this pump is 80 gallons per minute, and at that speed it would use 100 cubic feet of free air. This air must be delivered into the driving cylinders at 35 lbs. gauge measure.

Reasonable allowance has been made in the table for friction and clearance.

The throttle valve on the pump will control the air pressure, but it is advisable to proportion pumps as far as possible so that the air pressure needed in them is nearly equal to the pressure in the air mains near by. Pumps that move with very light pressure use more air for the same work.

For example, a gallon of water raised 175 feet by a 5 to 1 pump needs 1.6 cubic feet of air, whereas if the pump were 2 to 1, the air needed is only 1.15 cubic feet,—a saving of 28 per cent. in quantity of air. This is worth the consideration of parties who find their Compressors are becoming too small for their work. This point is also commended to the attention of those who think the pump takes little air, because "you only need to just lift the throttle off its seat the merest trifle."

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On the opposite page we have not considered the question of reheating, and here give a table showing the percentage required for the different kinds of power-actuated pumps, both for cold air and air reheated to 300 degrees Fah. at the pump engine.

Kind Engine.	Cold Air 60° Fah.	Reheated Air 300° Fah.
Direct Acting Single	1.	.69
Direct Acting Compound	70	.48
Crank and Fly Wheel Slide Valve	60	.41
Crank and Fly Wheel Slide Valve Compound	50	.33
Corliss Compound	33	.23

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Pump Table for Large Pumping Plants

For the convenience of engineers and others figuring on large pumping plants, to be operated by compressed air, we subjoin another table by which the pressure and volume of air required for any size pump can be readily ascertained. Reasonable allowances have been made for loss due to clearances in pump and friction in pipe.

Ratio of Diameters.	PERPENDICULAR HEIGHT, IN FEET, TO WHICH THE WATER IS TO BE PUMPED.															
	25	50	75	100	125	150	175	200	225	250	300	350	400	450	500	
1 to 1	13.75	27.5	41.25	55.0	68.25	82.5	96.25	110.0								Air Pressure at Pump.
	0.21	0.45	0.60	0.75	0.89	1.04	1.20	1.34								Cubic Feet of Free Air Per Gallon of Water.
1½ to 1		12.22	18.33	24.44	30.33	36.66	42.76	48.88	55.0	61.11	73.32	85.4	97 66			Air Pressure at Pump.
		0.65	0.80	0.95	1.09	1.24	1.39	1.53	1.68	1.83	2.12	2.41	2 70			Cubic Feet of Free Air Per Gallon of Water.
1¾ to 1			13.75	19 8	22.8	27.5	32.1	36.66	41.25	45.83	55.0	64.16	73 33	82.5		Air Pressure at Pump.
			0.94	1.14	1.24	1.30	1.54	1.69	1.84	1.99	2.39	2 59	2.83	3.19		Cubic Feet of Free Air Per Gallon of Water.
2 to 1				13.75	17.19	20 63	24.06	27.5	30.94	34 38	41.25	48.13	55.0	61.88	68.75	Air Pressure at Pump.
				1.23	1.37	1.52	1.66	1.81	1 96	2.11	2.40	2.69	2.98	3.28	3 57	Cubic Feet of Free Air Per Gallon of Water.
2¼ to 1					13.75	16.5	19.25	22.0	24.75	27.5	33.0	38.5	44.0	49.5	55.0	Air Pressure at Pump.
					1.533	1.68	1.83	1.97	2.12	2.26	2.56	2.85	3.15	3.44	3.73	Cubic Feet of Free Air Per Gallon of Water.
2½ to 1						13 2	15.4	17.6	19.8	22 0	26.4	30.8	35.2	39.6	44.0	Air Pressure at Pump.
						1.79	1.96	2.06	2.104	2.34	2.62	2.88	3.18	3.36	3.23	Cubic Feet of Free Air Per Gallon of Water.

To find the amount of air and pressure required to pump a given quantity of water a given height, find the ratio of diameters between water and air cylinders, and multiply the number of gallons of water by the figure found in the column for the required lift. The result is the number of cubic feet of free air. The pressure required on the pump will be found directly above in the same column. For example: The ratio between cylinders being 2 to 1. Required to pump 100 gallons, height of lift 250 feet. We find under 250 feet at ratio 2 to 1, the figures 2.11; 2.11 x 100–211 cubic feet of free air. The pressure required is 34.38 pounds.

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COMPRESSED AIR FOR HOISTING ENGINES

The following table is intended to give an approximate idea of the volume of free air required for operating hoisting engines, the air being delivered to the engines at 60 lbs. gauge pressure. There are so many variable conditions to the operation of hoisting by the hoisting engines in common use that accurate computations can only be offered when fixed data are given. In the table, the hoisting engine is assumed to actually run but one half of the time for hoisting, while the compressor, of course, runs continuously. If the engine run less than one-half the time, as it usually does, the volume of air required will be proportionately less, and *vice versa* The table is computed for maximum loads, which also in practice may vary widely. From the intermittent character of the work of a hoisting engine the parts are able to resume their normal temperature between the hoists, and there is little probability of the annoyance of freezing up the exhaust passages.

Table of the Volume of Free Air Required for Operating Hoisting Engines, the Air Compressed to 60 Pounds Gauge Pressure

SINGLE CYLINDER HOISTING ENGINE.							DOUBLE CYLINDER HOISTING ENGINE.						
Diam. of Cylinder Inches.	Stroke. Inches.	Revolutions per Minute.	Normal Horse Power.	Actual Horse Power.	Weight Lifted, Single Rope.	Cubic ft. of Free Air Required.	Diam. of Cylinder Inches.	Stroke. Inches.	Revolutions per Minute.	Normal Horse Power.	Actual Horse Power.	Weight Lifted, Single Rope.	Cubic ft. of Free Air Required.
5	6	250	3	5.9	600	75	5	6	200	6	11.8	1,000	150
5	8	160	4	6.3	1,000	80	5	8	160	8	12.6	1,650	160
6½	8	160	6	9.9	1,500	125	6¼	8	160	12	19.8	2,500	250
7	10	125	10	12.1	2,000	151	7	10	125	20	24.2	3,500	302
8½	10	125	15	16.8	3,000	170	8½	10	125	30	33.6	6,000	340
8½	12	110	20	18.9	5,000	238	8½	12	110	40	37.8	8,000	476
10	12	110	25	26.2	6,000	330	10	12	110	50	52.4	10,000	660
12	14	100	40	45.	.....	560	12	14	100	75	89.2	.....	1,125
14	18	90	50	65	.....	750	14	18	100	100	125.	.....	1,587

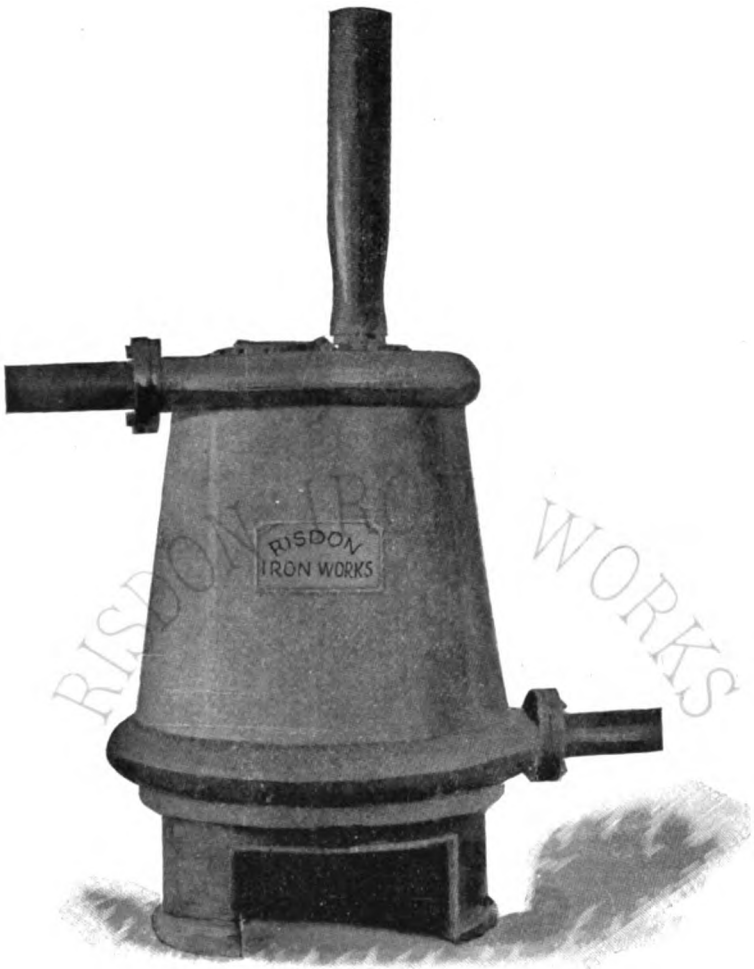
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Compound Corliss Hoisting Engines

Size	Cylinders.		Cubic Feet Free Air.	Brake H. P.
H. P.	L. P.	Strokes.		
10	14	30	665	75
12	18	30	1300	150
14	20	30	1600	200
14	20	36	2000	225

Initial Pressure, 70 pounds.
Intermediate Pressure, 23 pounds.
Final Pressure, 2 pounds.
Initial Temperature, 300 degrees Fah.
Final Temperature, 170 degrees Fah.
Cut off 55° of stroke.
Air before reheating, 60° Fah.

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RISDON AIR REHEATER

The accompanying cut represents Air Reheater in its simplest and most efficient form, the heater proper being made of two cast-iron shells, bolted together, having no tubes of any description to burn out or leak.

The heater is made in one size only, the extreme dimensions being 42 inches diameter by 54 inches high, the grate being 19 inches in diameter.

From tests made with this heater it has been found capable of heating 340 cubic feet of free air per minute at forty lbs. pressure to 360° F., giving a gain of 35 per cent. in the measured amount of the work done by the air after passing through the heater, compared with the same volume of air when used cold.

A heater of this size will heat less air to a higher temperature, or more air to a lower temperature, than stated above; but, if it should be required to heat more than 400 cubic feet of free air per minute, to get the best economy, it is advisable to use the heaters in series, allowing about 400 cubic feet of free air per minute for each heater. The heater should be placed as near as possible to the point where the air is to be used, and the outlet pipe should be as short as possible and well covered, so that the air will retain its heat. Weight, 2,300 lbs.

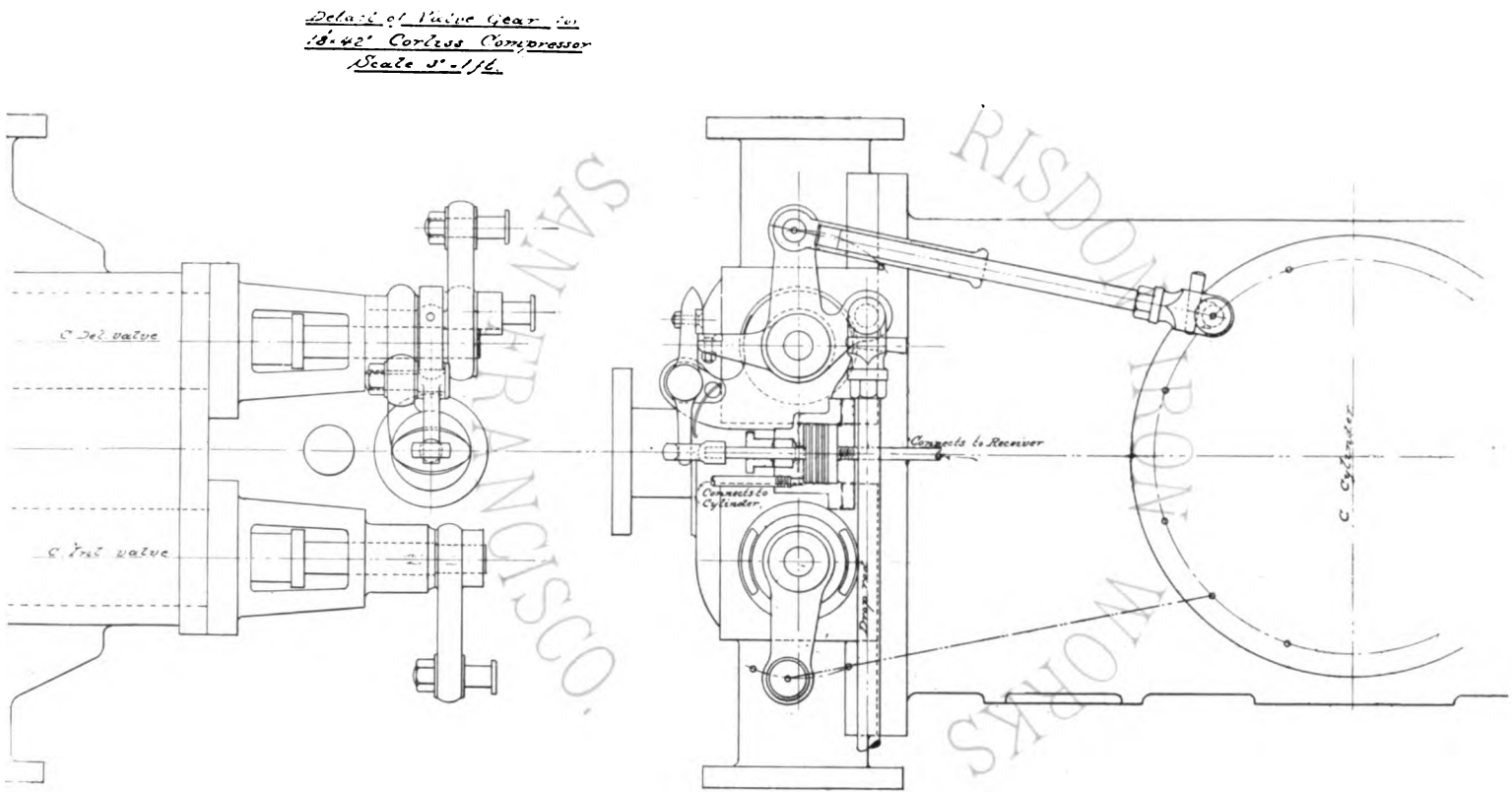
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Risdon Blowing Engines

On pages 78 and 79 we illustrate our Blowing Engines and are prepared to build both Horizontal and Vertical, Corliss or Poppet Valves on Steam Cylinders and our improved Corliss Air Inlet and Discharge Valves on Air Cylinder. See page 77.

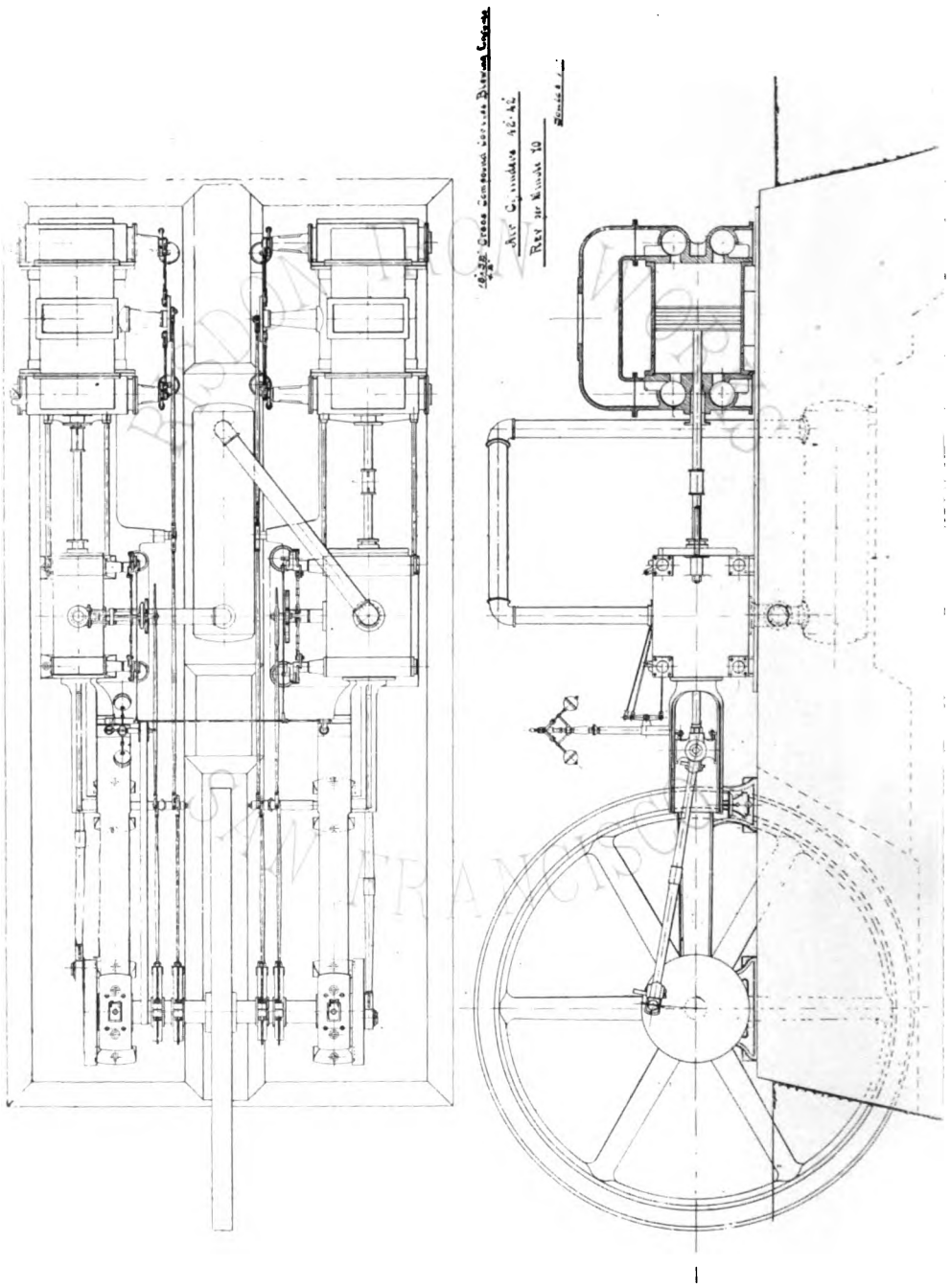
We build simple compound or triple expansion engines for any duty.

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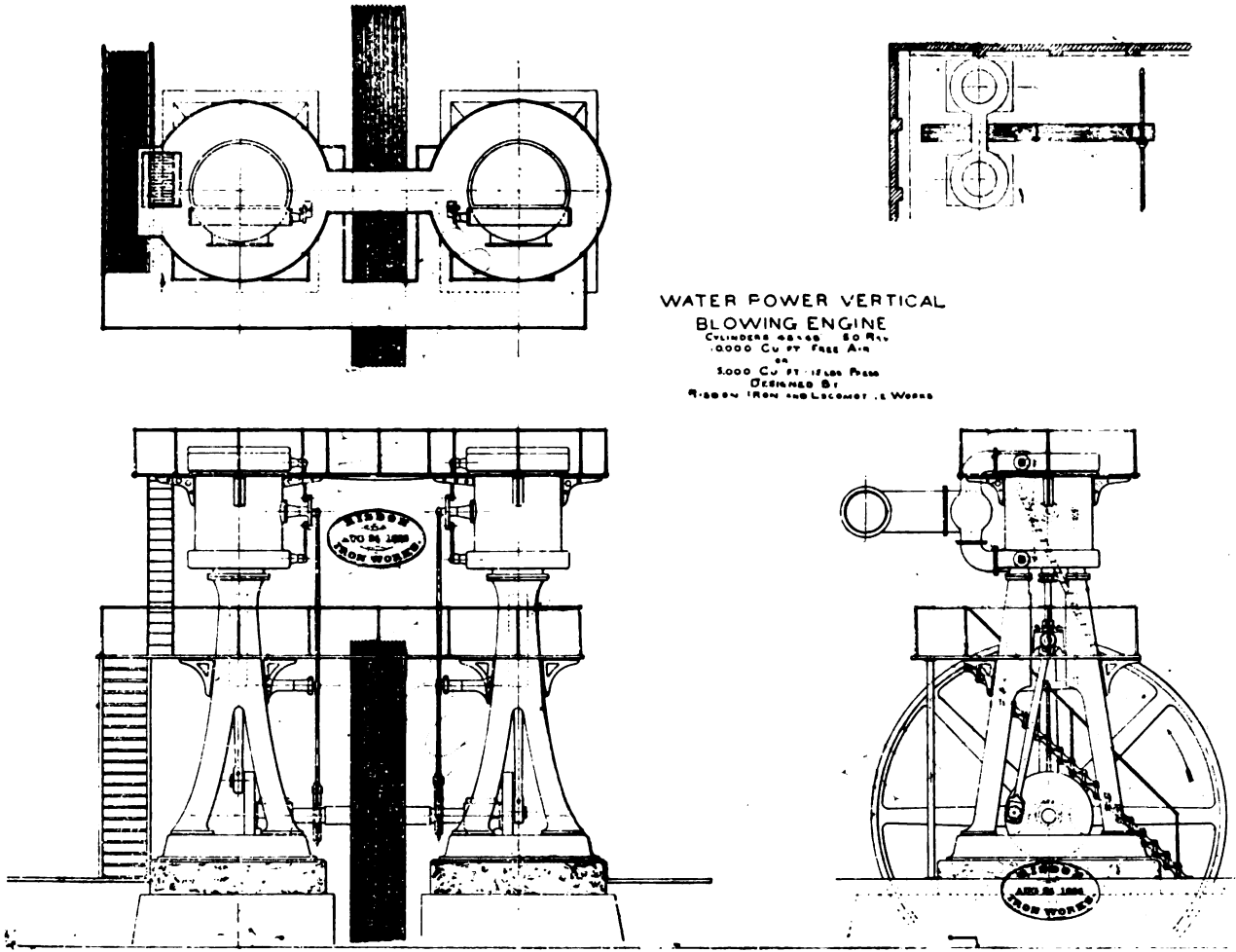
Valve Gear on our Corliss Valve Blowing Cylinders

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USEFUL COMPRESSED-AIR FORMULÆ

In the application of compressed air, errors sometimes occur because there are no available rules and formulæ which apply to the subject. I have, therefore, prepared the following simple formulæ, which I have used in my experience.

Rule to Describe the Isothermal Curve, or to Find the Pressure at Any Point in the Stroke of an Air Compressor During Isothermal Compression or Constant Temperature

Mariotte's Law: The pressure of any gas varies in the inverse ratio of the volume, the temperature remaining constant, or

(*a*) $$P' = \frac{P}{V}$$

P' being the absolute pressure at any point of the stroke;
P the original absolute pressure;
V the volume corresponding to the required point of the stroke.

Required the pressure at one-half the stroke, compressing isothermally:

$$P' = \frac{15}{\frac{1}{2}} = 30 \text{ lbs. absolute} - 15 = 15 \text{ lbs. gauge pressure.}$$

Required the pressure at seven-eighths of the stroke:

$$P' = \frac{15}{\frac{1}{8}} = 120 \text{ lbs. absolute} - 15 = 105 \text{ lbs. gauge pressure.}$$

Required the pressure at one-quarter of the stroke:

$$P' = \frac{15}{\frac{1}{4}} = 20 \text{ lbs. absolute} - 15 = 5 \text{ lbs. pressure.}$$

Mariotte's law also applies in determining change of pressure in volumes of compressed air due to change of volume.

Given a volume of air, say 1 cu. ft., at a pressure of 30 lbs. on the gauge, what will be the pressure indicated if this air is forced into one-half the space?

(*b*) $$P' = \frac{1 \times (30 + 15)}{\frac{1}{2}} = 90 \text{ lbs. absolute} - 15 = 75 \text{ lbs. gauge pressure.}$$

Reversing the Problem. Given a volume of air, say 1 cu. ft., at a pressure of 75 lbs. on the gauge, what will be the pressure indicated if this air is expanded to 2 cu. ft.?

$$P' = \frac{1 \times (75 + 15)}{2} = 45 \text{ lbs. absolute} - 15 = 30 \text{ lbs. gauge pressure.}$$

Example. A receiver 3 ft. in diameter and 6 ft. long is filled with compressed air which indicates 60 lbs. on the gauge. What will be the pressure if this volume of air is enclosed in a receiver 4 ft. in diameter and 12 ft. long?

Volume of first receiver $= 3^2 \times .7854 \times 6 = 42.4$ cu. ft.
Volume of second receiver $= 4^2 \times .7854 \times 12 = 150.8$ cu. ft.

$$P' = \frac{42.4 \times (60 + 15)}{150.8} = 21.1 \text{ lbs. absolute} - 15 = 6.1 \text{ lbs. gauge pressure.}$$

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The same rule applies in calculating volumes. In dealing practically with compressed air, we speak of pressure above the atmosphere, but in making calculations for volumes, serious errors frequently occur because the atmospheric pressure (15 lbs.) is lost sight of.

For instance, a cubic foot of air represents about 15 pounds absolute pressure, and if we wish to know what volume this cubic foot will occupy when it is subjected to a pressure (isothermally) of 60 pounds per square inch above the atmosphere, we must figure thus:

$$(c) \qquad V = \frac{1 \times 15}{60 + 15} = 0.20 \text{ cu. ft.}$$

Given 1 cu. ft. of compressed air, at 45 lbs. gauge pressure, what volume will this air occupy when subjected to a gauge pressure of 60 lbs.?

$$(d) \qquad V = \frac{1 \times (45 + 15)}{60 + 15} = 0.8 \text{ cu. ft.}$$

Free Air. By free air is meant air at atmospheric pressure, which is about 15 lbs. per square inch at sea-level.

Given a volume, say 500 ft. of free air, what volume will this air occupy when compressed (isothermally) to 60 lbs. gauge pressure?

$$V' = \frac{500 \times 15}{60 + 15} = 100 \text{ cu. ft.}$$

Reversing the Problem. How much free air is represented by 100 cu. ft. of compressed air at 60 lbs. gauge pressure?

$$V' = \frac{100 \times (60 + 15)}{15} = 500 \text{ cu. ft.}$$

Volumes of Free and Compressed Air Furnished by Air Compressors.

Example. The air cylinder of a compressor is 12 inches in diameter, stroke 18 inches. What volume of free air will it furnish (theoretical) when running at 120 revolutions per minute? 120 revolutions represent 360 ft. piston speed per minute.

$$12^2 \times .7854 = 113.1 \text{ area in square inches.}$$

$$\frac{113.1 \times 360}{144} = 282.7 \text{ cu. ft. free air.}$$

And by (c) $\dfrac{282.7 \times 15}{60 + 15} = 56.5$ cu. ft. of compressed air at 60 lbs. on gauge.

A rule by which volumes of compressed air may be approximately determined from volumes of free air is to divide by the number of atmospheres.

For instance, 60 lbs. represents 5 atmospheres (absolute); 500 cu. ft. of free air, divided by 5, equals 100 cu. ft. of compressed air at 60 lbs. gauge pressure.

As pressures are not always given in even multiples of atmospheres, this rule serves only to determine approximate results.

Reduced Efficiency of Air Compressors at Different Altitudes

The previous figures are based on the pressure of air at sea-level, or 15 lbs. (about) per square inch. As air compressors are frequently used at altitudes, it is

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desirable to know the extent to which an increased altitude affects the capacity of the compressor. Following are the barometric pressures at different altitudes:

Pressure at	¼	mile	above	sea level	14.02 lbs. per sq. in.
"	½	"	"	"	13.33 " " "
"	¾	"	"	"	12.66 " " "
"	1	"	"	"	12.02 " " "
"	1¼	"	"	"	11.42 " " "
"	1½	"	"	"	10.88 " " "
"	2	"	"	"	9.88 " " "

Free air as applied to the volume of a compressor, or the space traversed by the piston, is not affected by change of altitude, but free air when applied to pressures, either absolute or indicated, and to volumes of compressed air, is modified according to the density of the air at corresponding points.

Example. Required the volume in feet of cubic comprsseed air furnished by an air compressor when at work one mile above sea level. Also, the volume in cubic feet of free air representing the reduced efficiency of the compressor when at work at this altitude.

Given an air compressor of the following dimensions: Diameter 12 inches, stroke 18 inches, revolutions per minute, 120.

We have seen by a previous example that this compressor furnishes 282.7 cu. ft. of free air (theoretical) at sea level, and that this volume represents 56.5 cu. ft. of compressed air at 60 lbs. on the gauge. If this compressor is used at an altitude of one mile above the sea, what volume of compressed air will it furnish at 60 lbs. on the gauge, the speed remaining the same.

Free air furnished by compressor, 282 7 cubic feet.

Barometric pressure at altitudes of one mile, 12.02 lbs., then by *(c)* substituting the reduced barometric pressure we have

$$V' = \frac{282.7 \times 12.02}{60 + 12.02} = 47.18 \text{ cu. ft. at 60 lbs. on gauge.}$$

And if it is desired to know how many cubic feet of free air at sea-level are represented by 47.18 cu. ft. of compressed air at 60 lbs., we have by

$$(d) \qquad V' = \frac{47.18 \times (60 + 15)}{15} = 235.9 \text{ cu. ft. of free air at sea-level,}$$

and $282.7 - 235.9 = 46.8$ cu. ft. of free air, representing the reduced efficiency of the compressor when used at an altitude of one mile.

In practice, approximate determinations of the reduced efficiency of air compressors are made by deducting the percentage of difference between the barometric pressures at the respective altitudes.

The volume at sea-level being 1,

that at	¼	mile	above sea-level	will be	7% less.
"	½	"	"	"	11% "
"	¾	"	"	"	16% "
"	1	"	"	"	20% "
"	1¼	"	"	"	24% "
"	1½	"	"	"	28% "
"	2	"	"	"	34% "

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THE EFFICIENCY OF COMPRESSED AIR ENGINES

BY A PROMINENT PNEUMATIC ENGINEER.

(Republished.)

THE INCREASING USE which is being made of compressed air engines, for mine and underground work, stimulates the inquiry regarding their efficiency. By the term efficiency, we mean the percentage which the power given out by the Air Engine bears to the power required to compress the air in the Compressor.

THE SITUATION is apparently very simple. An engine drives an Air Compressor which forces air into a Reservoir. The air under pressure is led through pipes to the Air Engine and is there used after the manner of steam.

THE RESULTING POWER is frequently a small percentage of the power expended. In a large number of cases the losses are due to poor designing, and are not chargeable as faults of the system or even to poor workmanship.

THE LOSSES are chargeable, first, to friction of the Compressor. This will amount ordinarily to 15 or 20 per cent., and can be helped by good workmanship, but cannot probably be reduced below 10 per cent. Second, we have the loss occasioned by pumping the air of the engine room, rather than the air drawn from a cooler place. This loss varies with the season and amounts from 3 to 10 per cent. This can all be saved. The third loss, or series of losses, arises in the compressing cylinder. Insufficient supply, difficult discharge, defective cooling arrangements, poor lubrication, and a host of other causes, perplex the designer and rob the owner of power. The fourth loss is found in the pipe. This has heretofore received by no means the consideration which the subject demands. The loss varies with every different situation, and is subject to somewhat complex influences. The fifth loss is chargeable to fall of temperature in the cylinder of the air engine. Losses arising from leaks are often serious, but the remedy is too evident to require demonstration. No leak can be too small to require immediate attention. An attendant who is careless about packings and hose couplings will permit losses for which no amount of engineering skill can compensate.

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WE CAN ONLY REALIZE 100 PER CENT. EFFICIENCY in the Air Engine, leaving friction out of our consideration, when the expansion of the air and the changes of its temperature in the expanding or Air Engine cylinder are precisely the reverse of the changes which have taken place during the compression of the air in the compressing cylinder. But these conditions can never be realized. The air during compression becomes heated, and during expansion it becomes cold. If the air immediately after compression, before the loss of any heat, were used in an Air Engine and there perfectly expanded back to atmospheric pressure, it would on being exhausted have the same temperature it had before compression and its efficiency would be 100 per cent.

BUT THE LOSS OF HEAT after compression and before use cannot be prevented, as the air is exposed to such very large radiating surfaces in the Reservoir and Pipes, on its passage to the Air Engine. The heat, which escapes in this way, did, while in the compressing cylinder, add much to the resistance of the air to compression, and since it is sure to escape at some time, either in Reservoir or Pipes, it is evidently the best plan to remove it as fast as possible from the cylinder and thus remove one element of resistance. Hence we find that Compressors are almost universally provided with cooling attachments more or less perfect in their action, the aim being to secure isothermal compression, or compression having equal temperature throughout. Where the temperature rises, without check, during compression, the term adiabatic compression is employed.

IF AIR COMPRESSED ISOTHERMALLY be used with perfect expansion and the fall of temperature during expansion be prevented, then we will have 100 per cent. efficiency. But air will grow cold on being expanded in an engine and hence we conclude that warming attachments have the same economic place on an air engine, that cooling attachments have on an Air Compressor. In fact we find attachments of this kind, more particularly in large and permanently located engines, but for practical reasons their use on the most of engines for mine work is dispensed with, and the engines expand the air adiabatically, or without receiving heat.

THE PRACTICAL ENGINEER therefore has to deal with nearly isothermal compression, and nearly adiabatic expansion, and must also consider that the air in Reservoirs and Pipes becomes of the same temperature as surrounding objects. Consideration must also be had for the friction of the Compressor and the Air Engine. We find for the ordinary pressures, about 60 pounds, which are most commonly used, that the decrease in resistance to compression which is secured by the cooling attachments, is almost exactly equaled by the friction of the Compressor. Hence it is safe in calculating the efficiency of the Air Engine, to consider the Compressor as being without cooling attachments and also as working without friction. The results of such calculations will be too high efficiencies for light pressures, which are little used,—about correct for medium pressures which are commonly employed, and too low for high pressures, and will thus have the advantage of not being over-estimated. This result is

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occasioned by the fact that owing to the slight heat in compressing low pressures of air the saving of power by the cooling attachments is not equal to the friction of the machine, but at high pressures on account of the great heat, the cooling attachments are of great value, and save very much more power than friction consumes.

IN THE EXPANDING ENGINES the expansion never falls as low as the adiabatic law would indicate, owing to a number of reasons, but we will consider the expansion as being adiabatic, as an error in calculation caused thereby will be on the "safe side" and the actual power will exceed the calculated. We therefore consider the Compressor and Engine as following the adiabatic law of compression and expansion and as working without friction.

WITH THIS VIEW OF THE CASE, the efficiency of an air engine, working with perfect expansion, stated in percentages of the power required to operate the Compressor, can be placed as below for the various pressures above the atmosphere.*

Pressure above the atmosphere,	2.9 lbs.	94.85 per cent. efficiency.	
" " " "	14.7 "	81.79 "	"
" " " "	29.4 "	72.72 "	"
" " " "	44.1 "	66.90 "	"
" " " "	58.8 "	62.70 "	"
" " " "	73.5 "	59.48 "	"
" " " "	88.2 "	56.88 "	"

WE OBSERVE that the efficiencies for the lower pressures are very much greater than for the high pressures, and the conclusion is almost irresistible that to secure economical results, we must design our air engines to run with light pressures. And, in fact, the consideration of tables similar to the above, heretofore published by writers on this subject, has led many engineers into grave errors.

THE PIPE HAS BEEN ENTIRELY NEGLECTED. We notice that a pressure of 2.9 lbs. is credited with an efficiency of 94.85 per cent. It is clear that if the air were conveyed through a pipe, and the length of the pipe and the velocity of the flow were such that 2.9 lbs. pressure were lost in friction, then its efficiency instead of being 94.85 per cent. would be absolutely zero. It is therefore the power which we can get from the air after it has passed the pipe and lost a part of its pressure by friction that we must consider when we state the efficiency of our entire apparatus.

*In the above table, and in the tables hereafter given in this article, the air is considered as being expanded without receiving any heat. Larger returns can be had by heating the air.

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OUR TABLE OF EFFICIENCIES with a loss of 2.9 lbs. in the pipe, now gives us different values for the efficiencies at the various pressures:

Pressure above the atmosphere,				2.9 lbs.		00.00 per cent. efficiency.		
"	"	"	"	14.7	"	70.44	"	"
"	"	"	"	29.4	"	68.81	"	"
"	"	"	"	44.1	"	64.87	"	"
"	"	"	"	58.8	"	61.48	"	"
"	"	"	"	73.5	"	58.62	"	"
"	"	"	"	88.2	"	66.23	"	"

It will be noticed that the light pressures have lost most by the pipe friction; 2.9 lbs. having lost 100 per cent.; 14.7 lbs. 11 per cent., and 88.2 lbs. only a trifle over one-half of one per cent. We see that now 14.7 lbs. is apparently the economical pressure to use. But a further careful analysis of the subject shows that when the loss in the pipe is 2.9 lbs., then 20.5 lbs. is the most economical pressure to use and that the efficiency is 71 per cent. But 2.9 lbs. is a very small loss between Compressor and Air Engine, and cases are extremely exceptional where the friction of valves, pipes, elbows, ports, etc., does not far exceed this. Yet, with these conditions, which are very difficult to fill, we see that 20.5 lbs. is the lightest pressure which should probably be used for conveying power, and that 71 per cent. is an efficiency scarcely to be obtained, unless reheating the air is practiced.

CONTINUING OUR INVESTIGATION and taking examples where the pipe friction amounts to 5.8lbs., we find the efficiencies to correspond to the stated pressure:

Pressure above the atmosphere,				14.7 lbs.		57.14 per cent. efficiency.		
"	"	"	"	29.4	"	64.49	"	"
"	"	"	"	44.1	"	62.71	"	"
"	"	"	"	58.8	"	60.12	"	"
"	"	"	"	73.5	"	57.73	"	"
"	"	"	"	88.2	"	56.59	"	"

We again notice that as friction increases, or in other words, when we begin to use more air and make greater demands on the carrying capacity of the pipe, then we must increase the pressure very considerably to attain the most economical results. If the demands are such as to increase the friction and loss in pipe to 14.7 lbs., the air of 14.7 lbs. pressure at the Compressor is entirely useless at the Air Engine.

The table will stand thus:

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Pressure above the atmosphere,				14.7 lbs.		00.00 per cent. efficiency.		
"	"	"	"	29.4	"	48.53	"	"
"	"	"	"	44.1	"	55.13	"	"
"	"	"	"	58.8	"	55.64	"	"
"	"	"	"	73.5	"	54.74	"	"
"	"	"	"	88.2	"	53.44	"	"

It is to be noticed that 88.2 lbs. pressure has lost only about 3.5 per cent. of its efficiency by reason of as high a friction as 14.7 lbs. while the efficiency of the lower pressures has been greatly affected.

AS THE FRICTION INCREASES we see that the most efficient and consequently most economical pressure increases. In fact, for any given friction in a pipe, the pressure at the Compressor must not be carried below a certain limit. The following table gives the *lowest pressures* which should be used at the Compressor with varying amounts of friction in the pipe:

2.9 lbs.	friction		20.5 lbs.	at	Compressor.		70.92	efficiency.
5.8	"	"	29.4	"	"	"	64.49	"
8.8	"	"	38.2	"	"	"	60.64	"
11.7	"	"	47.0	"	"	"	57.87	"
14.7	"	"	52.8	"	"	"	55.73	"
17.6	"	"	61.7	"	"	"	53.98	"
20.5	"	"	70.5	"	"	"	52.52	"
23.5	"	"	76.4	"	"	"	51.26	"
26.4	"	"	82.3	"	"	"	50.17	"
29.4	"	"	88 2	"	"	"	49.19	"

So long as the friction of the pipe equals the amounts given, an efficiency greater than the corresponding amounts stated in the table cannot be expected. If we should have a case which corresponded to any of these cited in the table, we could only increase efficiency by reducing the friction.

AN INCREASE IN THE SIZE OF PIPE will reduce friction by reason of the lower velocity of flow required for the same amount of air. But many situations will not admit of large pipes being employed, owing to considerations of economy outside of the question of fuel or prime motor capacity.

AN INCREASE OF PRESSURE will decrease the bulk of air passing the pipe, and in that proportion will decrease its velocity. This will decrease the loss by friction, and, as far as that goes, we have a gain. But we subject ourselves to a new loss, and that is the diminishing efficiencies of increasing pressures. Yet as each cubic foot of air is at a higher pressure and therefore carries more power, we will not need as many cubic feet as before for the same work. It is obvious that, with so many sources of gain or loss, the question of selecting the proper pressure is not to be decided hastily.

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AS AN ILLUSTRATION of the combined effect of these different elements we will suppose a very common case.

Compressor 102 revolutions, pressure 52.8 lbs., loss in pipe 14.7 lbs., machine in mine running at 38.2 lbs., efficiency 55.73.

So long as the friction of the pipe amounts to 14.7 lbs., we have seen that 52.8 lbs. is the best pressure and 55.73 the greatest efficiency. We will reduce the friction by reducing the bulk of air passing through the pipe. We reduce the cylinder of the Air Engine so that it requires 47 lbs. pressure to do the same work as before. We find now the friction of pipe drops to 11.7 lbs. The pressure on the Compressor rises to 58.8 lbs., its number of revolutions falls to 100 and the resulting efficiency is 57.22 per cent.

Another change of pressure on Compressor to 64.7 lbs. would decrease its revolutions to 93, friction to 8.8 lbs., and efficiency would rise to 57.94 per cent. Still again increasing pressure to 73.5 lbs. we have only 84 revolutions of Compressor, 5.8 lbs. loss in pipe and efficiency of 57.73 per cent. In this last case the efficiency begins to fall off a little, and higher pressures would now show less efficiency, but, in comparison with the first example, we find we are doing the same work in the mine with a trifle less power and with a decrease of nearly 20 per cent. in the speed of the Compressor.

OTHER COMMON EXAMPLES can be shown where an increase of pressure would result in wonderful increase in efficiency and economy. There are many cases where light pressures and high velocity in the pipe will convey a given power with greater economy than higher air pressures and lower speed of flow through pipe. But these cases arise mostly when the higher air pressures become very much greater than are at present in common use.

THEREFORE IN ESTIMATING THE EFFICIENCY of the complete outfit we find that the pipe and the pressure are very important elements and must be determined with care and skill to secure the most satisfactory results. As the volume and power of air varies with its pressure, the size and consequent cost of Compressor for a certain work would also be affected by the pressure. To plan an outfit for a mine, due regard must be had for cost of fuel or prime motor power, and cost of Compressor, pipes and machinery, as the saving in one is often secured by a sacrifice in the other.

Next to determining the size of pipe, the skillful engineer has need of further care in the proper position of Reservoirs, Branches, Drains and other attachments, as only by the exercise of good judgment in this can satisfactory work be secured.

Reverting now to the subject of reheating, several systems have been suggested and used.

If the only object was to preclude the obstruction of the exhaust ports by the formation of ice due to the moisture of air, it would be obtained by the application to this portion of the engine of some source of heat, such as a lamp, or an injection of steam or of hot water.

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This process, however, hardly deserves more than a mere mention, for if such a source of heat is handy, it can be used to far better advantage in heating the air, either in the cylinder or before entering it.

One method consists in injecting into the cylinder a spray of warm water, whose heat is absorbed by the air, while the water is cooled. The annexed table gives the weight of water at 75 degrees, 100 degrees, and 150 degrees Fahr. to be supplied for each pound of air expanding to the atmospheric pressure from 70, 80, 90, and 100 lbs. gauge, so that the final temperature of air will be 32 degrees Fahr., its initial temperature being 60 degrees Fahr.

Gauge Pressure of Air	B. T. U. Required per lb. of Air	Pounds of Water per lb. of Air, the Temperature of Water being		
		75° Fahr.	100° Fahr.	150° Fahr.
Lbs.	(A)	Lbs.	Lbs.	Lbs.
70	59.	1.37	.86	.5
80	62.8	1.46	.92	.53
90	66.2	1.54	.97	.56
100	69.2	1.61	1.02	.6

Another and better method is to inject steam instead of hot water into the cylinder. The advantages of this system are, first, that steam, being in a gaseous state, mixes up with air more readily than water, even finely pulverized, and besides, the condensation of this steam gives up its latent heat, which increases considerably the heating of air.

A comparison of this process with the previous one can readily be made. Assuming that a spray of water at 212 degrees Fahr. is injected into the cylinder, each pound of this water will give up 180 B. T. U. before it is cooled to 32 degrees Fahr.

But, taking steam at atmospheric pressure, i. e., also at 212 degrees Fahr., 1 lb. of steam, in the process of liquefaction, will abandon 966 B. T. U., its latent heat of vaporization, and besides 180 B. T. U. as above, making a total of 1146 B. T. U.

The following table gives the weight of steam at 212 degrees Fahr. required for each pound of air to prevent its temperature from falling below 32 degrees Fahr. at complete expansion.

Gauge Pressure of Air Lbs.	B. T. U. Required for each lb. of Air	Lbs. of Steam at 212 Degrees per lb. of Air
70	59.0	.051
80	62.8	.055
90	66.2	.059
100	69.2	.0604

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It is evident that quite similar calculations could be made to maintain the exhaust temperature at any given point. Besides, the use of steam keeps the walls of the cylinder wet, and while water alone is a poor lubricant between metallic surfaces, it facilitates the action of the regular lubricants, and is also favorable to the tightness of the piston packing.

It will readily be seen that both these methods completely preclude the formation of ice in the exhaust ports; their good effect is still more pronounced if the cylinder is provided with a jacket, into which hot air is circulated.

Air can also be reheated before being admitted into the cylinder. Various designs of heaters are used for this purpose, the air generally passing through a system of pipes heated by an interior furnace, a flue being provided for the passage of the hot gases on the outside of the pipes before they reach the chimney. And as air, on account of its bad conductivity, does not easily take up heat from the metallic sides of the pipes, it is expedient to inject in the pipes a small quantity of water, which absorbs the heat more readily and penetrates with the hot air into the cylinder.

Another method of heating is to place a lamp or gas jet within the air pipe. The use of coal or wood is not advisable in this case, as grit and cinders would be carried by the current of air into the motor.

Reheating by the electric current is still in the experimental state.

When the motor is a compound machine, the air should be again reheated after it has done work in the H. P. cylinder, and before it is admitted to the L. P. cylinder.

If the heating is done by passing the air through heated pipes, the fuel consumption will be very small, as practice shows that 1 lb. of coal gives the air from 8,000 to 10,000 B. T. U. in a properly designed heater.

To utilize the full benefit of reheating and of air expansion in compound engines, an early cut-off is very desirable. This can be accomplished by reheating to 350 degrees before the air enters each cylinder.

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Table showing temperature of dry air at the end of its compression to different gauge pressure in adiabalic compression, i. e., supposing that no portion of the heat developing is lost in the course of compression.

Absolute Pressure. (Lbs. per sq. in.)	Gauge Pressure. (Lbs. per sq. in.)	Fah. temperature, in degrees, at end of compression.
14.7	0	60
16.17	1.47	74.6
18.37	3.67	94.8
22.05	7.35	124.9
25.81	11.11	151.6
29.4	14.7	175.8
36.7	22	218.3
44.1	29.4	255.1
51.4	36.7	287.8
58.8	44.1	317.4
73.5	58.8	369.4
88.2	73.5	414.5
102.9	88.2	454.5
117.6	102.9	490.6
132.3	117.6	523.7
147	132.3	554
220.5	205.8	681
294	279.3	781
367.5	352.8	864

The different styles of jacketing and spray injection will show from 75 to 90 per cent of isothermal efficiency.

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TRANSMISSION OF POWER BY COMPRESSED AIR

The advantage of transmitting power by compressed air is daily gaining in importance, and we take this opportunity of placing before the public an example of plants of this kind.

200-horse power, delivered by wheel and transmitted 2 miles through 7-inch pipe, the pressure at power station to be 80 pounds, the line loss will be 3 pounds, and the air delivered will be 1200 cubic feet (free air) at a pressure of 77 pounds.

The available work performed by this air, if used cold, will be 55 per cent, and if reheated to 300 degrees, will be 80 per cent, and if reheated to 350 degrees, will be 85 per cent.

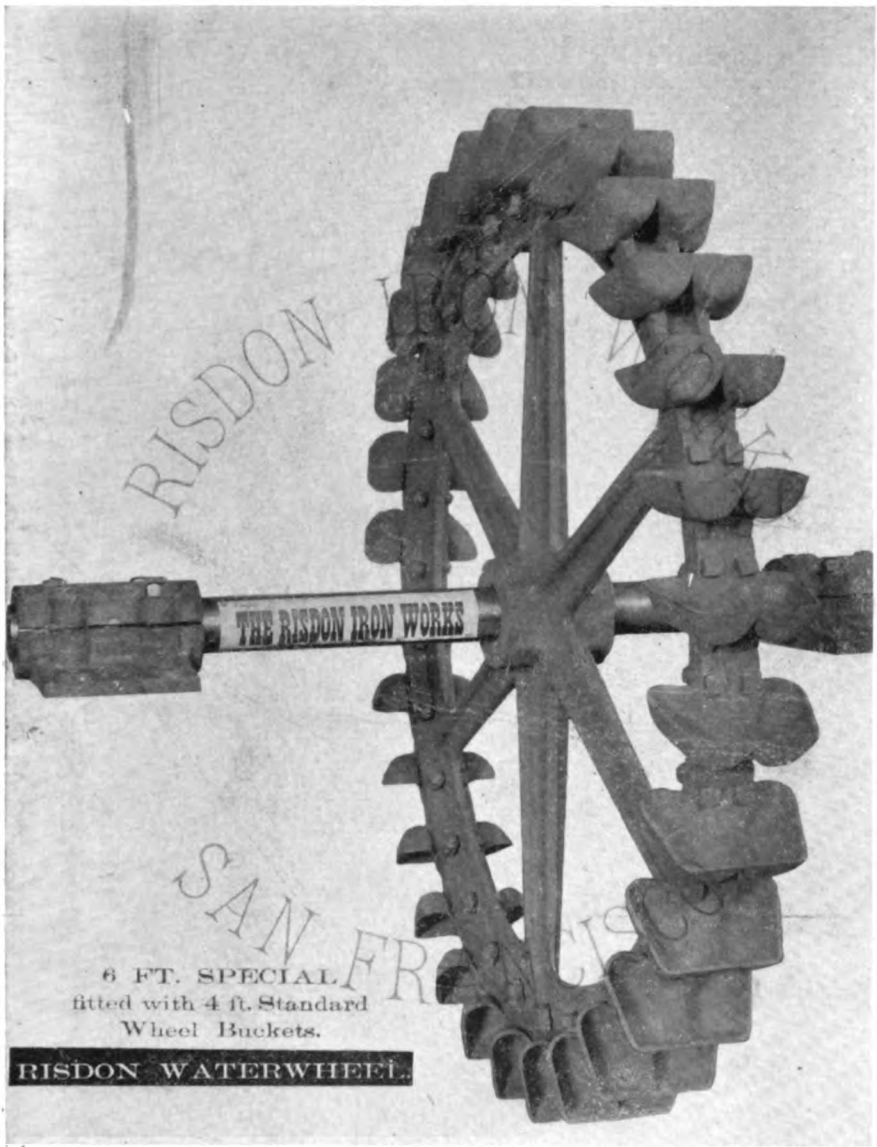
The fuel required to do this reheating will be about 1 cord per 24 hours.

The above air will run a 40-stamp combination mill; also 2 rockbreakers and a hoisting engine, capable of hoisting 200 tons of ore per day; also the necessary drills and blower engine used in ventilation.

We assume in the above that 1 lb. wood will yield 5000 B. T. U.

We illustrate a large compressor of this kind on pages 31, 33 and 35.

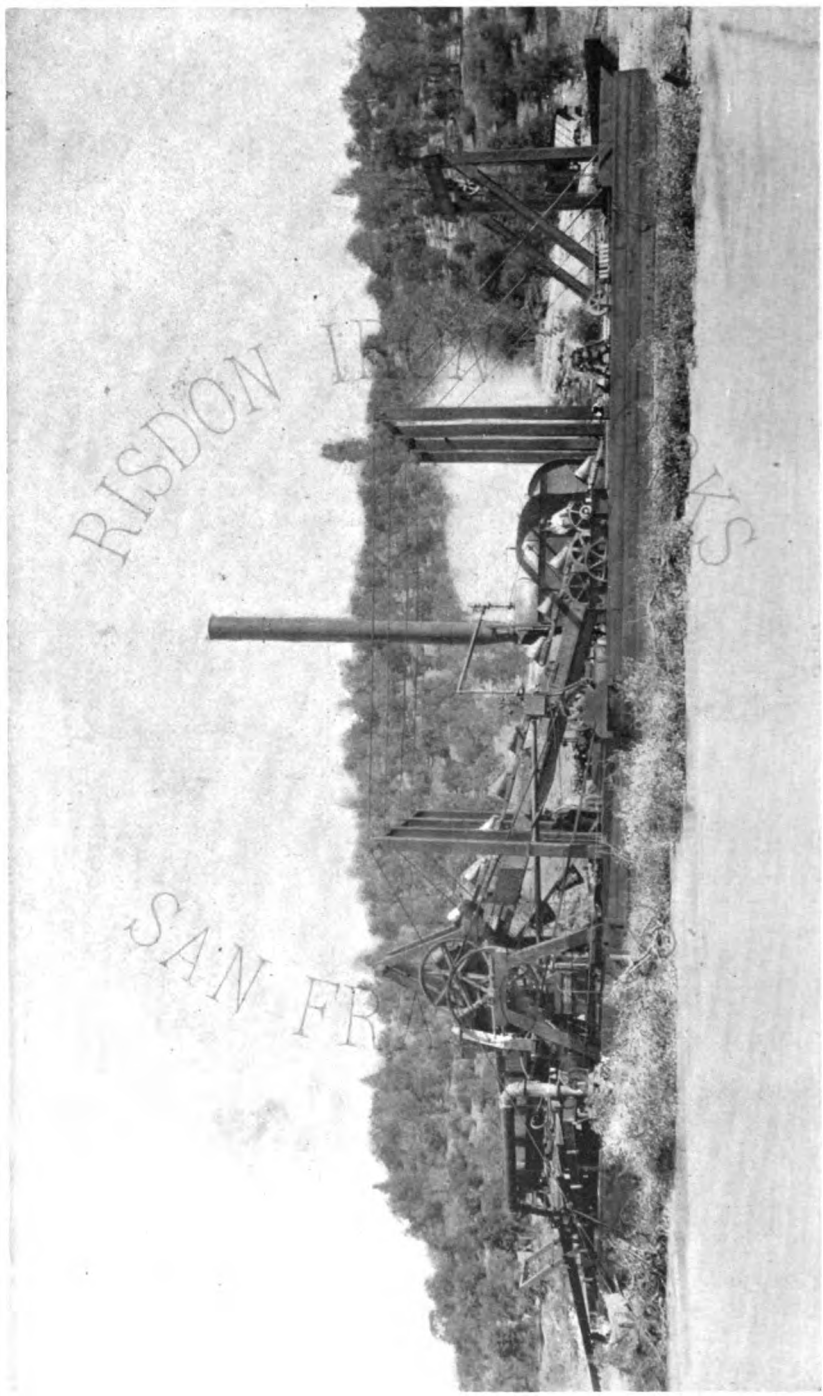
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This wheel developes 300-horse power running 280 revolutions per minute, under a hydrostatic head of 500 feet.

(Page from Water Wheel Catalogue, No. 4)

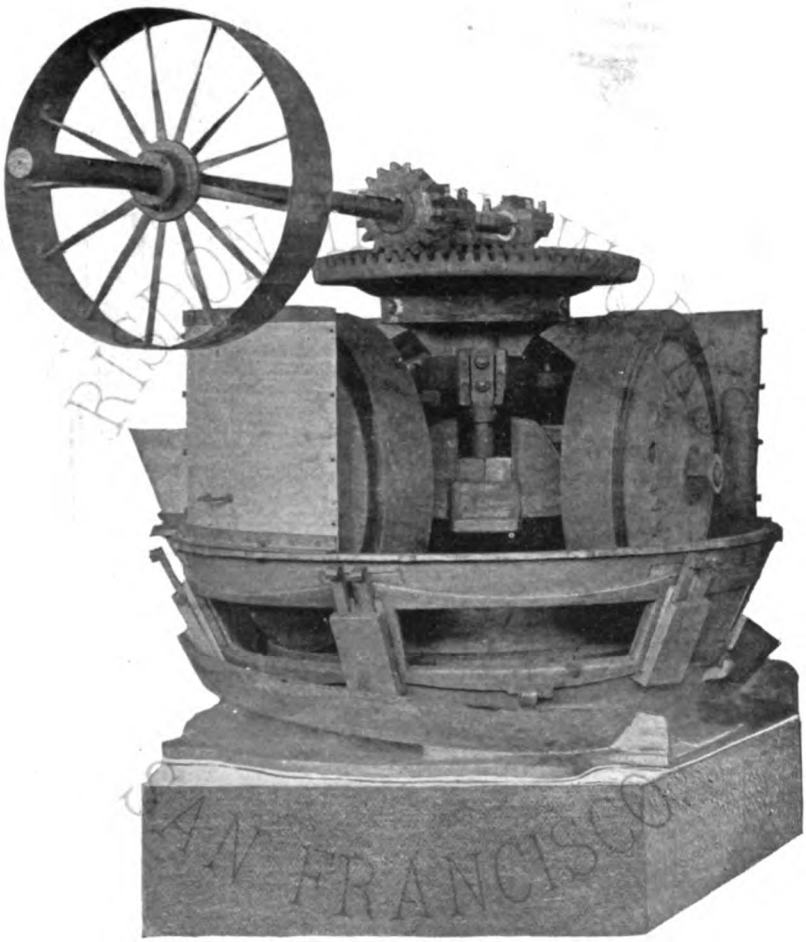
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Page from Gold Dredging Catalogue No. 15

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Bryan Roller Quartz Mill

ADAPTED TO THE

Milling and Reduction of Gold and Silver Ores

(Page from Bryan Mill Catalogue, No. 8)

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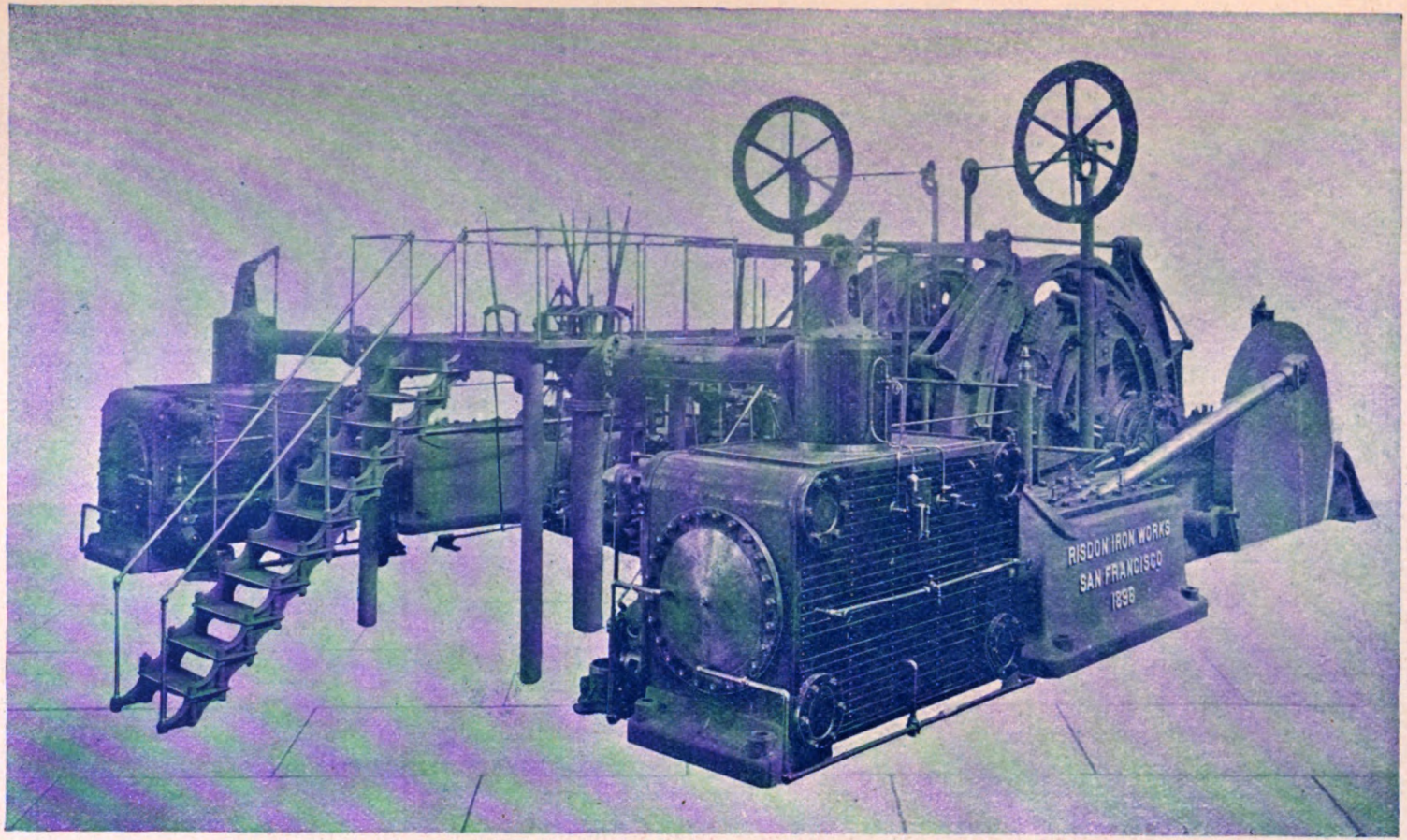


60-Stamp Concentrating Gold Mill, "Water Power," 900 lb. Stamps, crushing 280 tons ($4\frac{66}{100}$ tons per stamp) per day, through 40 mesh screen. All Machinery built by Risdon Iron Works. (Page from Milling Catalogue No. 12.)

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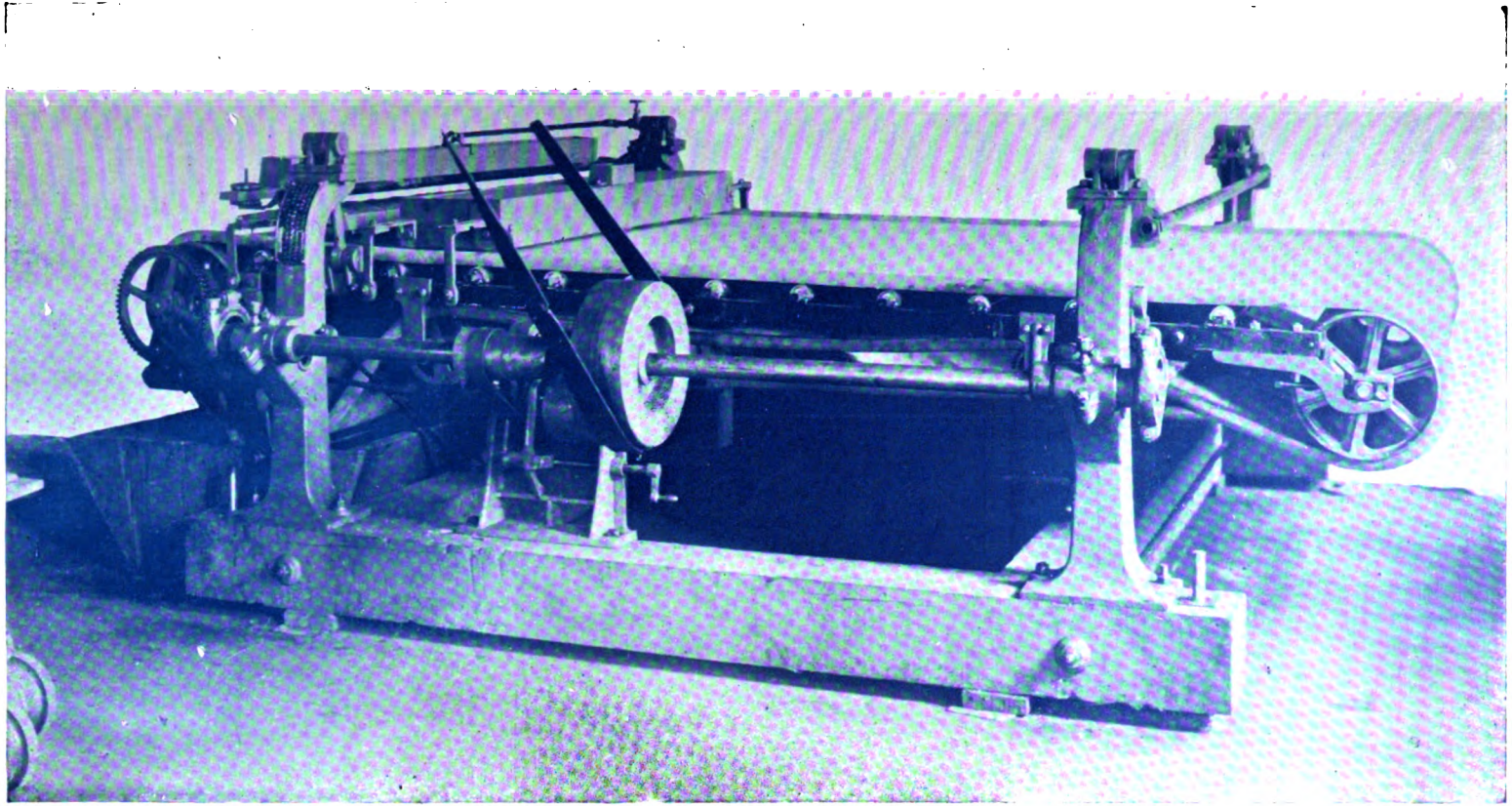
3000 HORSE POWER HOISTING ENGINE

Page from Hoisting Catalogue No. 3



Direct Acting Hoisting Engine, to start load 40,000 lbs. and hoist same at an average speed of 3000 feet per minute. Capacity, 3500 feet Rope.

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Johnston Concentrator, Risdon Iron Works, Sole Manufacturers.

(Page from Johnston Concentrator Catalogue No. 14)

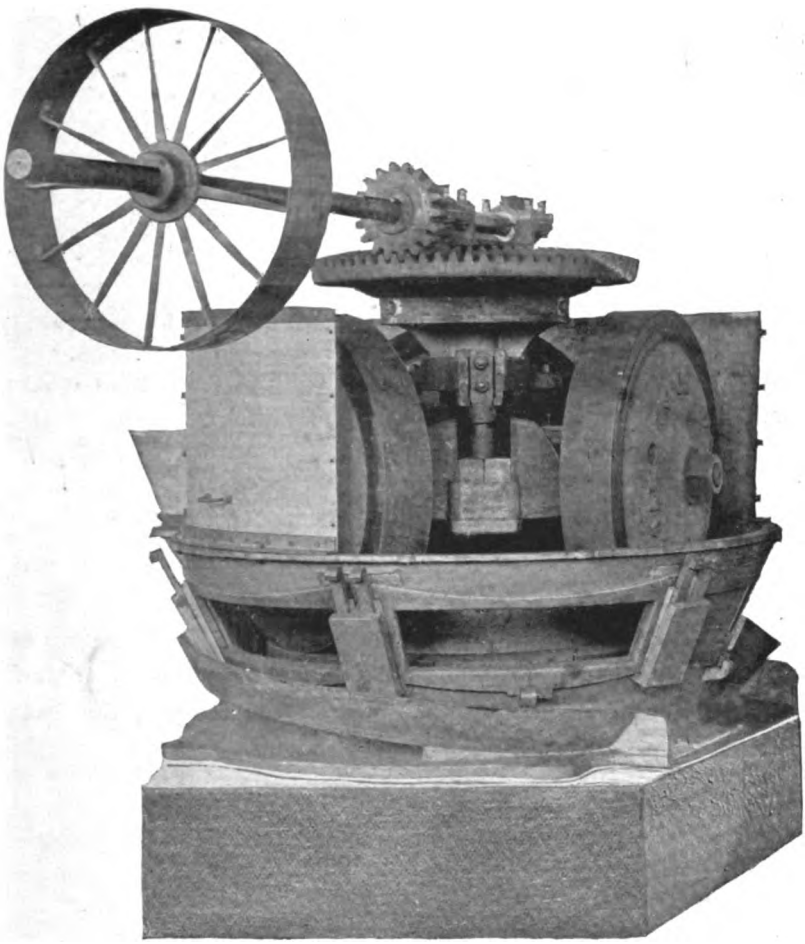
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Catalogue No. 8

Bryan Roller Quartz Mill

. . . ADAPTED TO THE . . .

MILLING AND REDUCTION OF GOLD AND SILVER ORES



PUBLISHED BY

THE RISDON IRON WORKS

SAN FRANCISCO, CAL.

1897

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Give full shipping directions with order. State whether preference is to be given to a certain route, and, if so, give the name of railroad, etc.

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PRESS OF
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PREFACE.

In presenting this tenth edition of our Catalogue No. 8, mainly devoted to the description of the Bryan roller quartz mill, we take pleasure in calling the miners' attention to a machine, that, in these days of new inventions, proves that the old principles of milling are hard to excel. The old Arastra, which probably was used earlier than stamps, is still in use in its crude form, and in many instances considered superior to new and improved machinery. The Arastra "did the work," and did it well,—and so did the Chilean mill, which may be considered developed from the Arastra. But greater capacity was required, and, as the stamp battery at that time was the only machine arranged for a continuous crushing process, it took the lead, as its capacity was so much greater. As for amalgamation, the principle of the Arastra and Chilean mills was considered superior to stamps. Many different kinds of roller mills were tried; but they were too complicated and difficult to keep in repair, and the oil could not be prevented from dropping into the pulp, which made the quicksilver unable to amalgamate with the gold. It was after many years of experimenting and at considerable expense that the RISDON IRON WORKS was able to put a mill on the market that embodied all the advantages of the crude Arastra and Chile mill, and at the same time possessed the simplicity and durability that is required in mining machinery. At present several hundred of these machines are in successful operation in this country as well as Mexico and many other places.

Being the largest manufacturers of mining machinery on the Pacific Coast, and having built a great number of quartz mills, among which is the 240 stamp mill of the Alaska Mill and Mining Company, the largest stamp mill in the world, as well as some of the largest pumping and hoisting plants in this country, we are in possession of a large and complete set of drawings and patterns of machinery required for any purpose and of any magnitude.

We cheerfully invite correspondence on any subject and in any language, and will furnish specifications and prices upon application.

THE RISDON IRON WORKS.

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The Bryan Roller Quartz Mill.

On the opposite page we present a half-tone illustrating this well-known mill. It is constructed on the principle of the Chile mill, except that it has three rollers arranged to run in a continuous discharging pan. The mill is arranged for crushing either gold or silver ores, with inside or outside silver plates.

Plate No. 1 illustrates the construction of this mill, which consists of an annular cast-iron mortar containing fixed steel dies arranged in the path of its three crushing rollers.

The crushing weight of the rollers varies as to their size; and in smaller size mill can, at small additional cost, be arranged so that the weight can be increased by loading a tank over driving pulley.

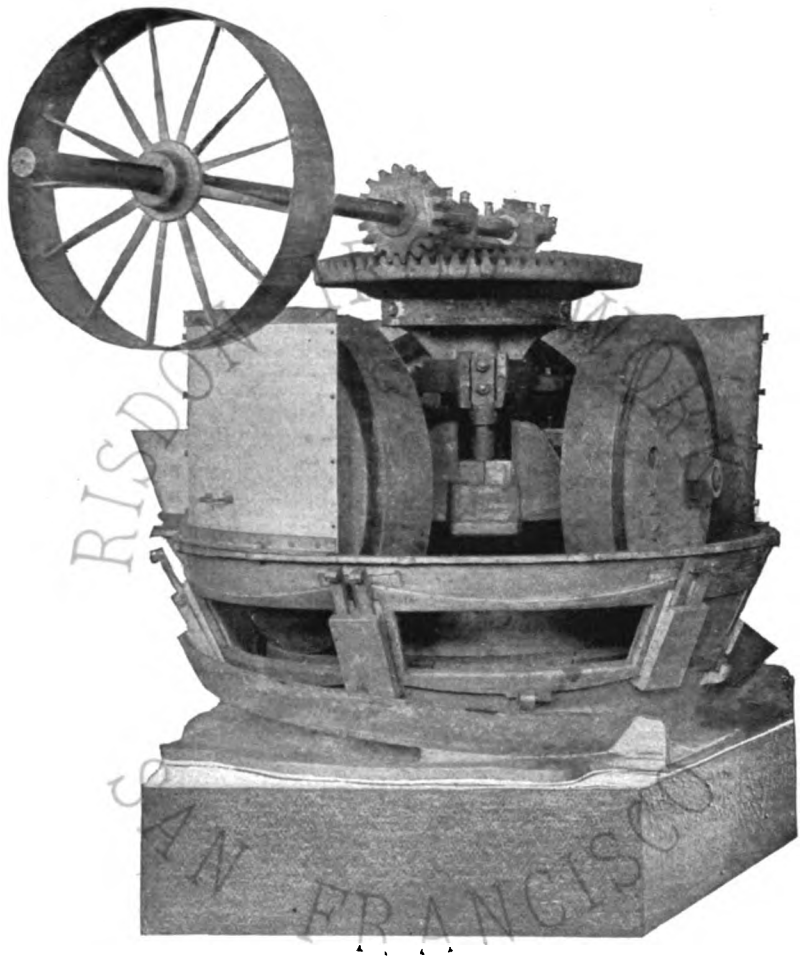
Power is applied from a pulley through a bevel gear and pinion secured to the stationary center post, which makes a very direct application of power. The rollers are journaled in a centrally revolving table driven from the overhead driver by an arm containing a ball and socket journal. The centrally revolving table is supported on a steel center post, and is movable up and down this post as the wear on dies increases or through any inequality in hardness of the rock. It is also provided with a double ball and socket bearing, which will prevent any jar on axles.

Supported from the overhead driver are three steel arms carrying wire brushes, which follow the path of the die, keeping it clean, and at the same time assisting or retarding the discharging as required. Around the outside of the pan or mortar are the screens, which are fastened on the outside, secured by screen frames and keys.

Another patented improvement in this mill is, when the dies are new, a guard plate can be attached to the inside of the screen so as to prevent the rock from punching holes in screens and also regulating the height of discharge. This is a very valuable feature of the mill; and no mill constructed on the lines of the Chile mill can be a success without it. The top of the pan presents a flanged surface to which is attached a sheet steel casing. This extends over the top of the rollers; and the joint (being water-tight) keeps the floor of mill comparatively clean. On the outside of the gutters, around the bottom of the mortar, we also have a guard plate which prevents splash. To the back of the pan is a projection in the casing, bolted onto which the lip of the ore feeder rests to feed the mill. Directly opposite this point is the chute or main discharge, to which can be attached the sluice with copper plates.

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The Bryan mills have been in use throughout this country for the past ten years, and are now in successful operation in all the principal mining States of the United States, Mexico, Lower California, Central and South America, Alaska, British Columbia, Tasmania and Australia.



The Bryan Roller Quartz Mill.

The advantages we claim over any other mill are:

1st. It has a larger screen capacity and free discharge.

2d. It amalgamates a larger percentage of gold.

3d. Its foundations are simple and cheap.

4th. It is quickly and cheaply erected.

5th. It requires a smaller amount of power per ton of ore crushed than any other mill.

6th. It crushes hard as well as soft ore.

7th. Its slow speed prevents the extraordinary wear and tear of high speed machines.

8th. As a gold amalgamator it is superior to all other mills, not excepting stamps.

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9th. The last claim we make for this mill is perhaps the most important in milling practice. The amalgamation in any mill cannot take place too soon; and, in the Bryan, we have saved as high as ninety per cent within the mortar.

Around the central cone of the mortar we place copper plates,—silver plated when ordered,—which greatly add to its amalgamating qualities. The amalgam can be seen in the mill while in motion, as it collects around the central cone (where the motion of the pulp is the least) as fast as it is liberated from the matrix, and consequently is not subject to grinding or flouring of quicksilver.

In the operation of the mill, the pulp runs around the mortar next to the screens in a rapid current, but, towards the center, inside the rollers, the movement of the pulp is much slower; and, as the gold is liberated from the matrix, it falls to the eddy side of the current, and in practice is found amalgamated in mass around the cone in the center of the mortar. By this action the free gold is not subjected to the continuous grinding of the rollers in the mass of pulp, and nearly all the gold is retained in the mortar.

Another point in which the Bryan mill is superior to stamps or any other mill is that it does not slime the ore, and the sand and pyrites are left of uniform size in the best condition for concentrating.

The clean-up of the mill, owing to its simple arrangement, is done with the greatest ease. The mill is built throughout of the best quality of iron and specially selected steel, and is thoroughly finished in all its parts.

Another point greatly in favor of the Bryan mill over stamps is low cost for buildings and foundations. As will be seen in plates showing foundations and general arrangement of mill, the erection costs but very little; and the difference in favor in the erection of the five-foot mill (as compared with ten stamps) has in some cases amounted to $2,500.00 in favor of the Bryan. The building can be made much lighter, and the cost for transportation of timbers will amount to considerably less.

We build the Bryan mill in two sizes, known as the four and five foot mills, the former only being built in sections for mule transportation.

This mill is invaluable to prospectors, as it is easily removed from place to place, and requires no skilled labor to erect or run it.

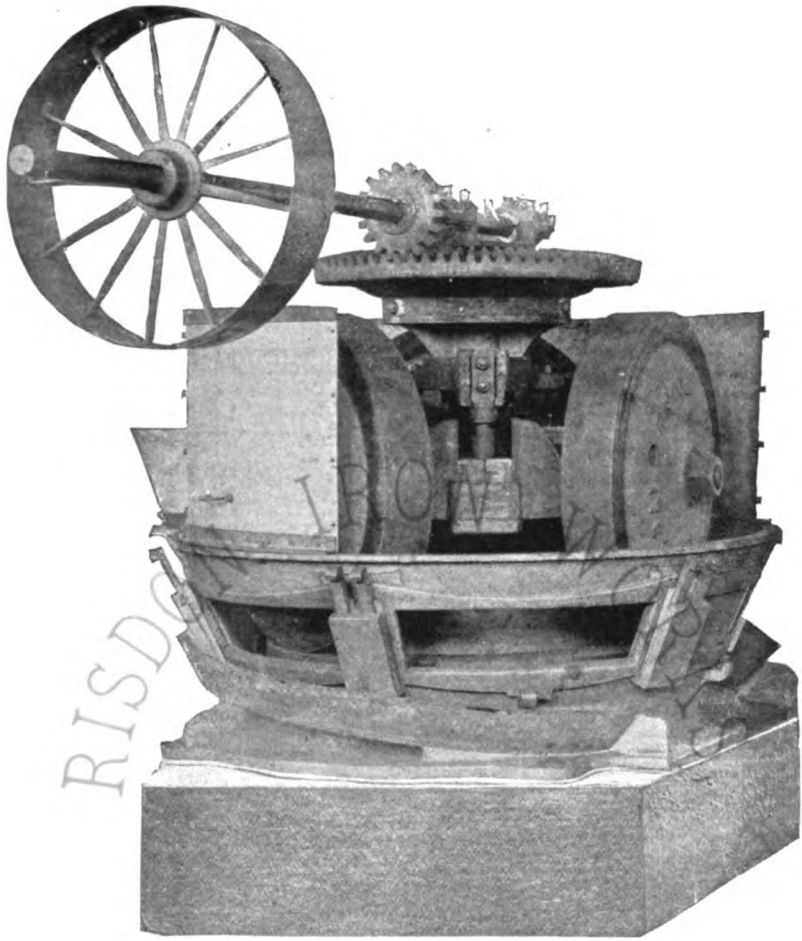
Size.	Speed of Drum.	Capacity, Tons per Day.	H.-P.	Weight, Lbs.	Price.
5 feet	40 revolutions	25 to 35	10	22,000	$2,450
4 "	60 "	12 " 20	5	12,000	1,800
4 " sectional . . .	60 "	12 " 20	5	13,000	2,000

We manufacture complete gold and silver mills, in connection with these pulverizers, as follows:

1st. Plain gold mills, steam or water power.
2d. Concentrating gold mills, steam or water power.
3d. Wet crushing silver mills, steam or water power.

We furnish plans and estimates, and quote prices for complete mills on application.

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Five-foot Bryan Roller Quartz Mill.

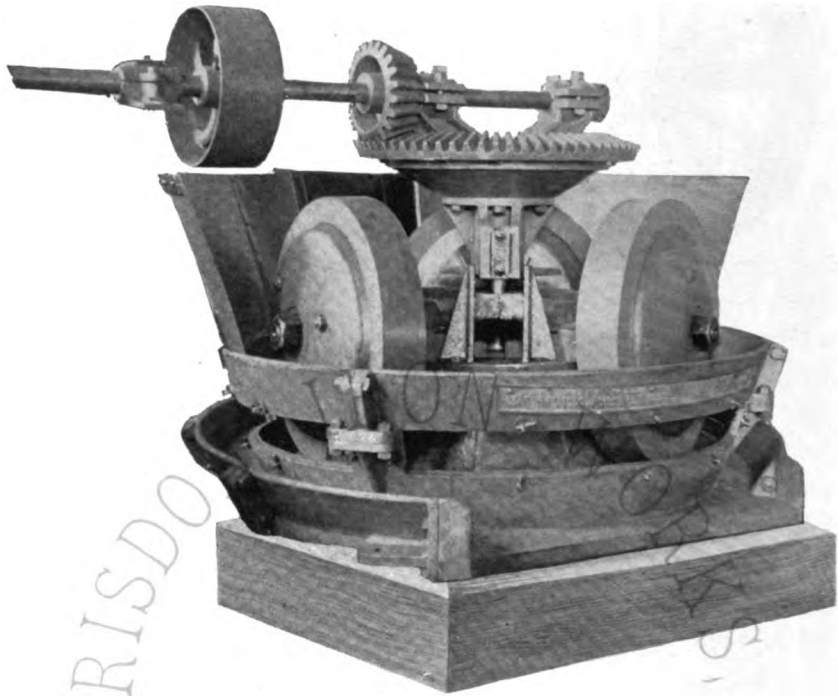
The illustration above represents a five-foot Bryan mill. This mill is in use in all sections of the country, and is to-day the largest and most economical crusher manufactured in this or any other country. In this mill the rollers are forty-four inches in diameter, seven inches face, and weigh 3,650 pounds each. The axles are very strong and heavy and securely fastened to the centrally revolving table. The tires made of the best quality of locomotive tire steel, and are not cast but rolled.

A set of wearing parts for this mill consists of three tires weighing 1,100 pounds each, and one set of dies consisting of ten pieces weighing about 175 pounds each, making total set of wearing parts 4,050 pounds. With this mill we have crushed from four thousand to eight thousand tons of ore to a set of wearing parts; and in the mill of the Bullion-Beck and Champion Mining Company, Eureka, Utah, crushing thirty-three tons of ore to each mill per day, we have reduced the cost of wear and tear on tires and dies to seven (7) cents per ton of ore. This is a record hard to beat.

This mill is adapted to crushing gold and silver ores, and is particularly well adapted to the recrushing of jig tailings or middlings in concentrating mills; and the principal plant in the State of Utah is equipped with Bryan mills, of which we print description in another part of our catalogue.

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Our Four-foot Bryan Mill.



The four-foot mill is similar in construction to the five-foot, having rollers weighing about 1,200 pounds each. This weight can be increased if desired by placing a loading tank over top. This mill is in great favor throughout Mexico, and in countries where the five-foot mill cannot be transported. Some of the most successful mines in Mexico, notably the Candelaria Consolidated, the Santa Eduwiges, the Castellana and the Jalisco, are using this size mill as well as a number of others, and it is one that has made a very great record. At the Candelaria we have crushed with this mill twelve tons in twenty-four hours through a sixty mesh screen; fifteen tons in twenty-four hours through fifty mesh; eighteen tons through forty mesh. This proportion has been continuous.

A set of wearing parts of this mill consists of four rolled steel tires weighing about 1,500 pounds, and eight steel dies weighing about 1,100 pounds, making weight of total set 2,600 pounds, and will crush from 1,600 to 2,500 tons of ore.

This mill is adapted to either gold or silver ores; and, in another part of this catalogue, we illustrate complete plants in which they are used.

Four-foot Sectional Mill.

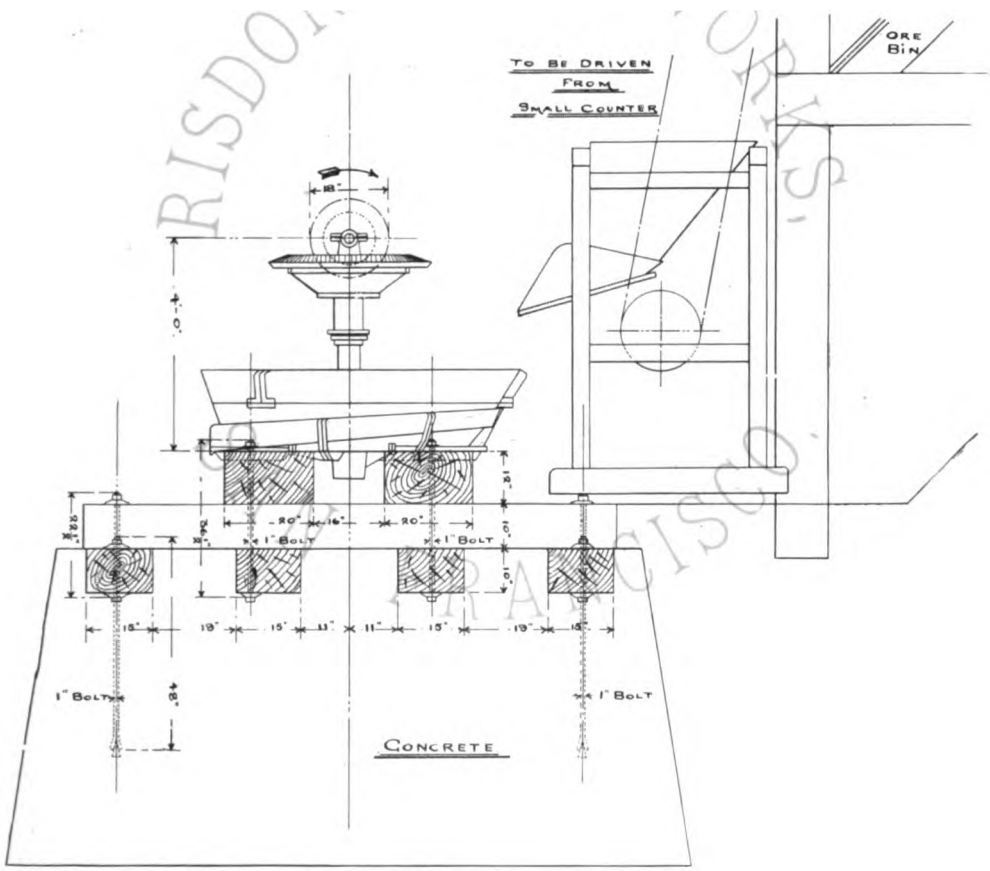
We also build this four-foot mill in sections for transportation on mule-back, in which no piece weighs over 350 pounds. This is a mill very popular in sections which are inaccessible for larger pieces; and we have a very large number of them in different parts of this country and Mexico running for the last eight to ten years. The mill is quickly erected; and, as all joints are thoroughly faced and made to template, there is no leakage whatever.

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PLATE No. 1.

illustrates foundation necessary for the five-foot Bryan mill. It will be noticed that the quantity of timber is exceedingly small; and, in that part marked "concrete," stone can be used. The foundation is comparatively inexpensive, and holds the mill firmly, and prevents any crystallization of the pan mortar through jar. The ore feeder is shown illustrated with the casing, which we previously mentioned under mortar lip, taken away. This will give a clear idea of what is required in the shape of foundation for this mill. The four-foot mill foundation is similar to this, but smaller.

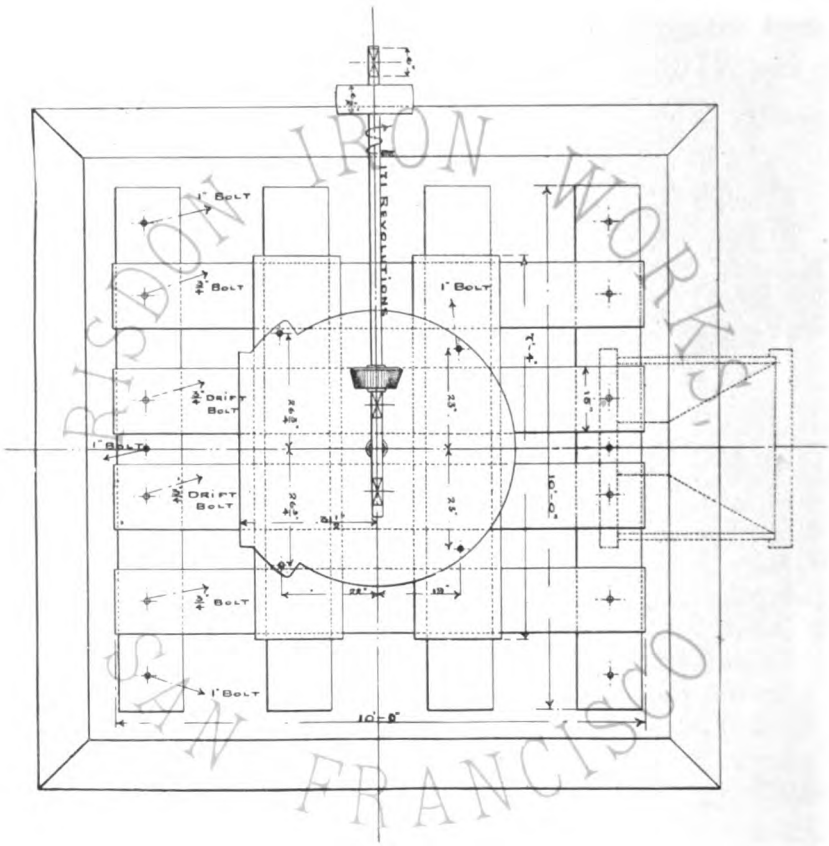
Plate No. 1.



Foundation Plan Five-foot Bryan Mill.

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Plate No. 2.



Foundation Plan Five-foot Bryan Mill.

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Silver Plates.

With the Bryan mill we furnish if required amalgamating copper plates as follows:

Five-foot mill. A set of copper plates, including three pieces cut to template to fit around the cone; two pieces (one right and one left hand) chute plate; six pieces cut to template for gutters; one or two pieces for the apron sluice.

The smallest quantity which should be ordered with the five-foot mill should be thirty-four (34) square feet. This will cost, with one ounce of silver per square foot, one hundred and twenty-four ($124.00) dollars.

With the four-foot Bryan mill we furnish the same number of pieces as for the five-foot, except that they are smaller; and the smallest quantity that should be ordered with the mill should be 21½ square feet, which will cost eighty ($80.00) dollars. These prices are in addition to the regular prices of the Bryan mill.

WATER REQUIRED.

Approximate quantity of water required for five-foot mill is 400 to 1,000 gallons per hour.

Approximate quantity of water required for four-foot mill is 300 to 750 gallons per hour.

Weight of heaviest piece in the five-foot mill is the pan, which weighs 5,300 pounds. The weight of the heaviest piece in the four-foot solid mill is the pan, which weighs 3,250 pounds.

DUPLICATE PARTS.

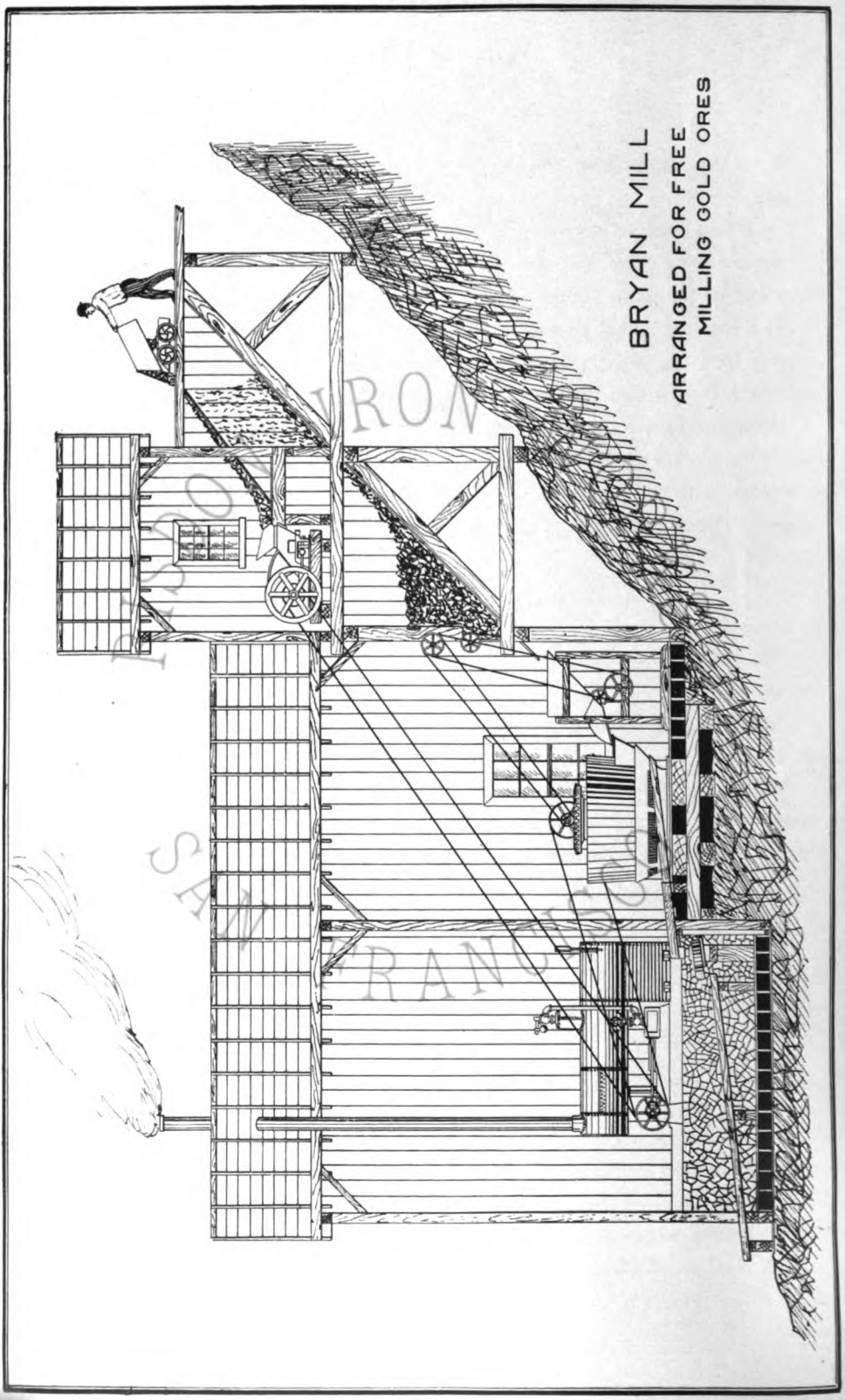
We carry in stock duplicate parts for all our mills, and can fill orders for wearing parts on short notice.

PLATE No. 3

shows general arrangement of the Bryan mill arranged for free milling of gold ores. This plant consists of a fire box boiler; plain slide valve engine; either a four-foot or five-foot Bryan mill with rock breaker; automatic ore feeder; silver plates with the necessary shafting, boxes, pulleys and belts for its operation. We have a number of plants of this character in operation throughout this country, all of which give the greatest satisfaction, and we refer to testimonial No. 9 for same.

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Plate No. 3.



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show the same mill driven by a gas engine, and consisting of the same parts as previously mentioned. This is a mill that is very popular in the desert countries and places where fuel and water cut quite a considerable figure. This mill is running in Death Valley, California, in one of the most desolate regions in the world.

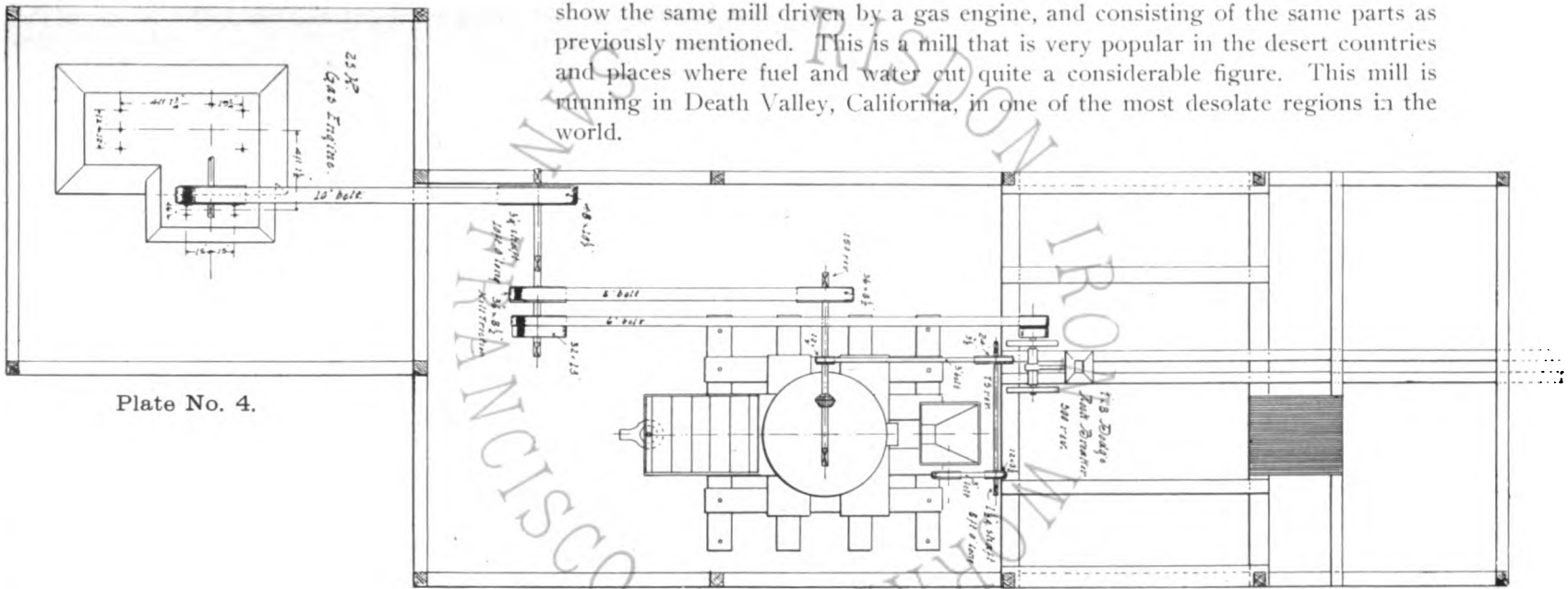


Plate No. 4.

Free-milling Bryan Mill Plant.

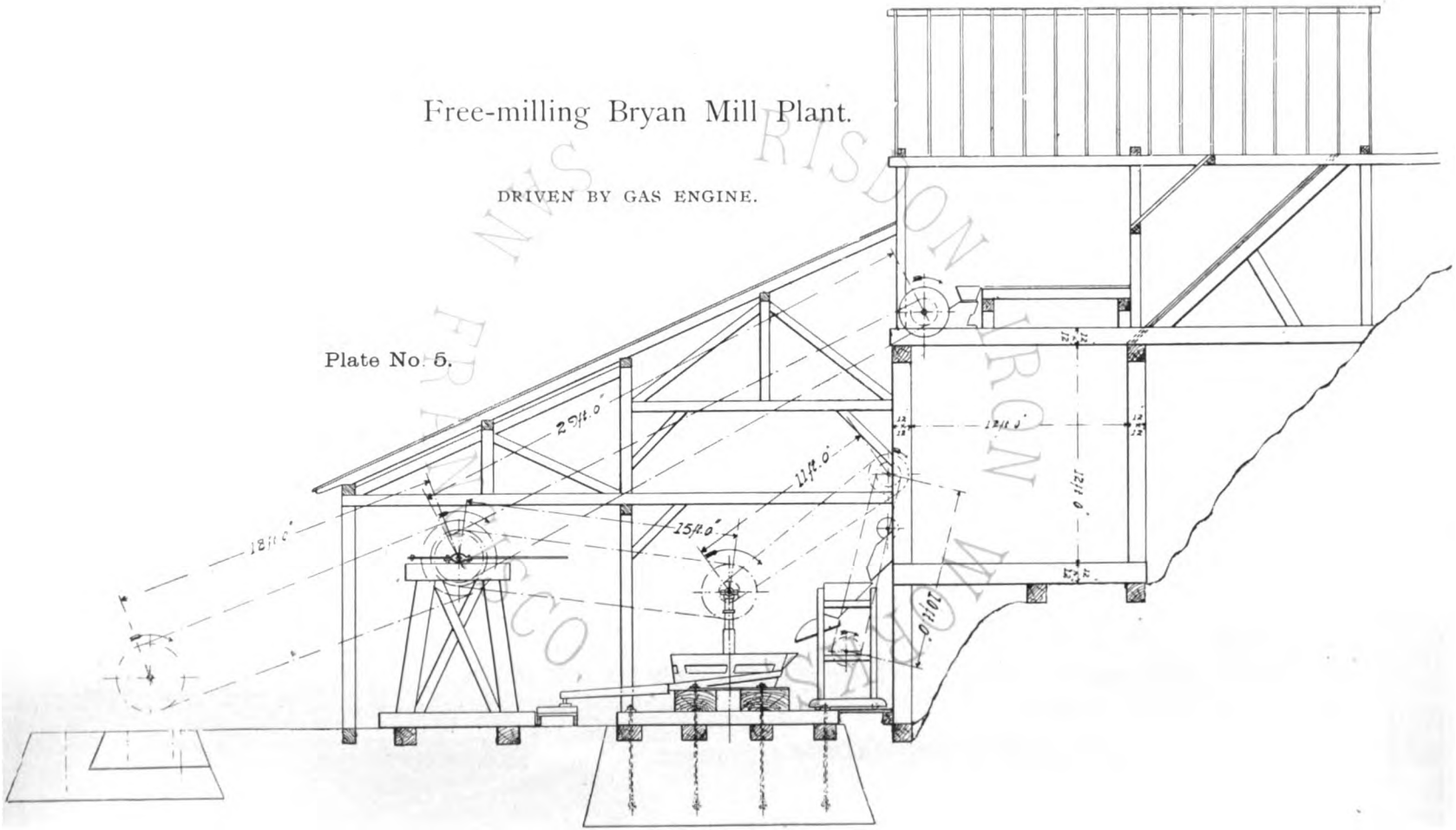
DRIVEN BY GAS ENGINE.

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Free-milling Bryan Mill Plant.

DRIVEN BY GAS ENGINE.

Plate No. 5.



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Concentrating Bryan Mill Plant.

Plates Nos. 5 and 6 illustrate the general arrangement of our concentrating gold mill. This mill is driven by steam power, and consists of the engine, boiler, feed pump and heater, grizzly, rock breaker, ore feeder, Bryan mill—either four or five foot—with copper plates, and two six-foot Johnston concentrators, together with the necessary shafting, pulleys, boxes and belts for its successful operation. This is a very complete plant, and we refer to testimonial No. 12 as to its performance.

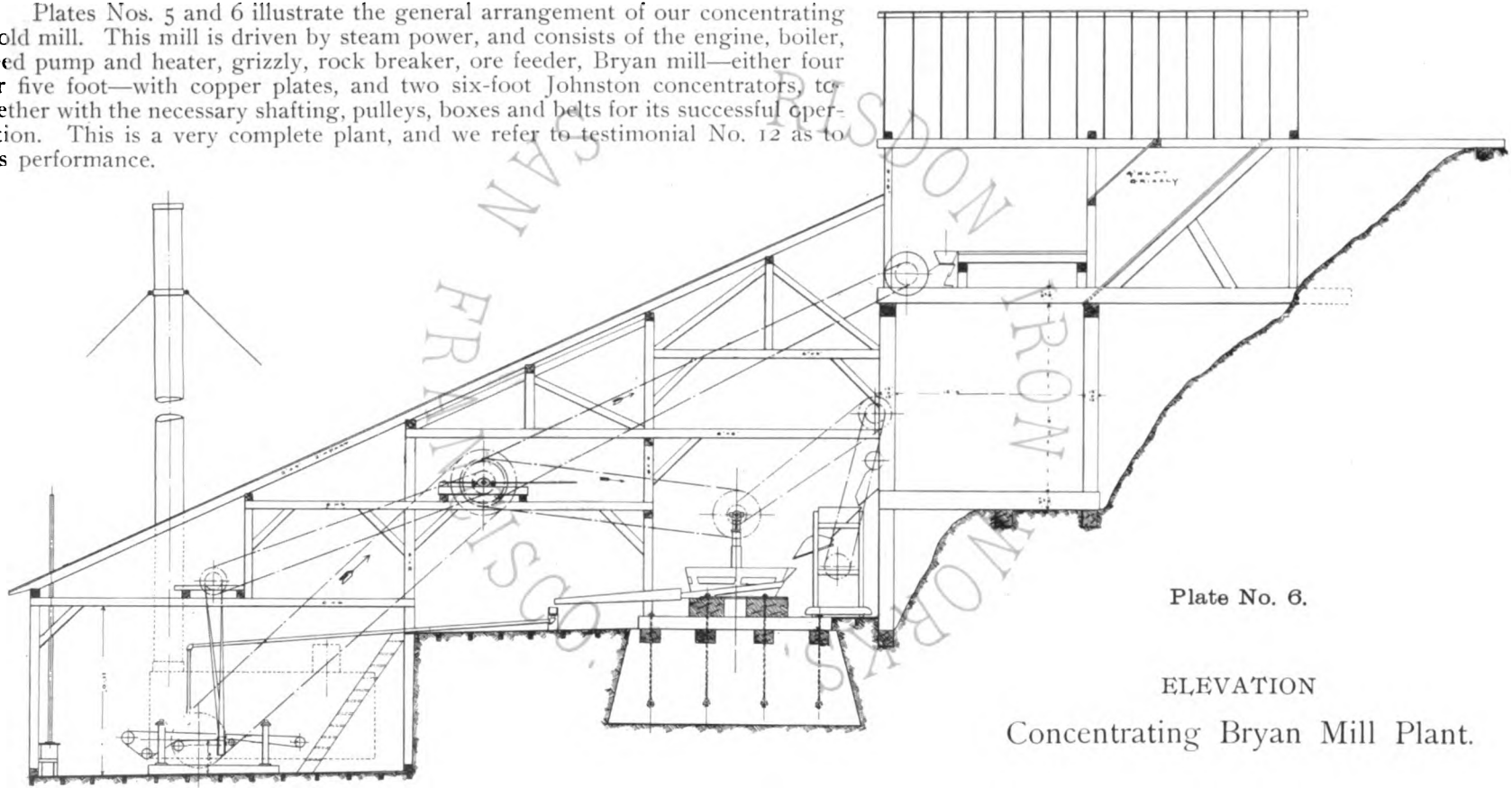


Plate No. 6.

ELEVATION

Concentrating Bryan Mill Plant.

PATTISON IRON WORKS, SAN FRANCISCO, CAL.

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Plan Concentrating Bryan Mill Plant.

CONSISTING OF

1 Five-foot Bryan Mill.
2 Six-foot Johnston Concentrators.
1 Slide-valve Engine.
1 Columbia Boiler.

Capacity.....25 to 35 tons per day.

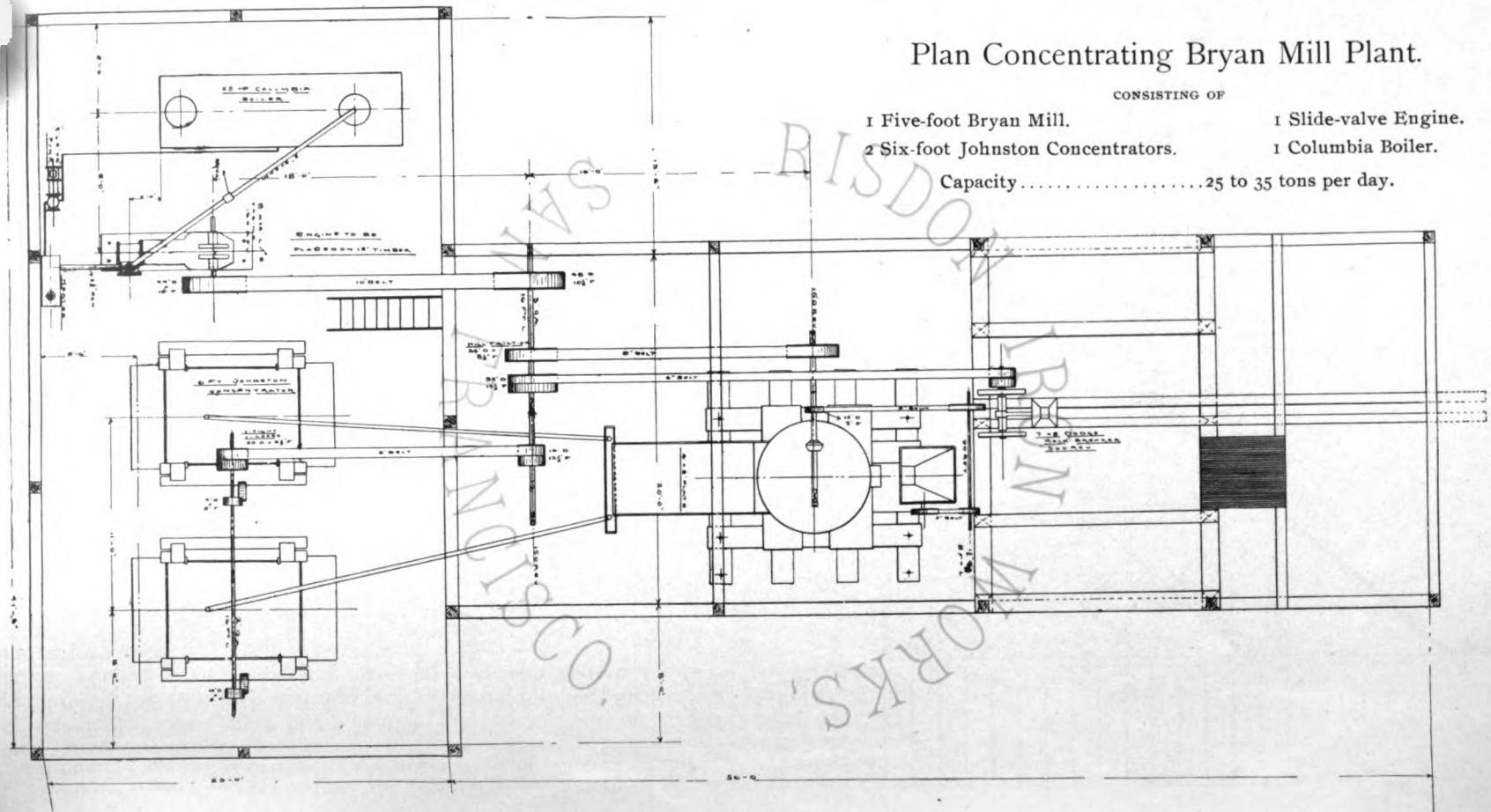


Plate No. 7.

RISDON IRON WORKS, SAN FRANCISCO.

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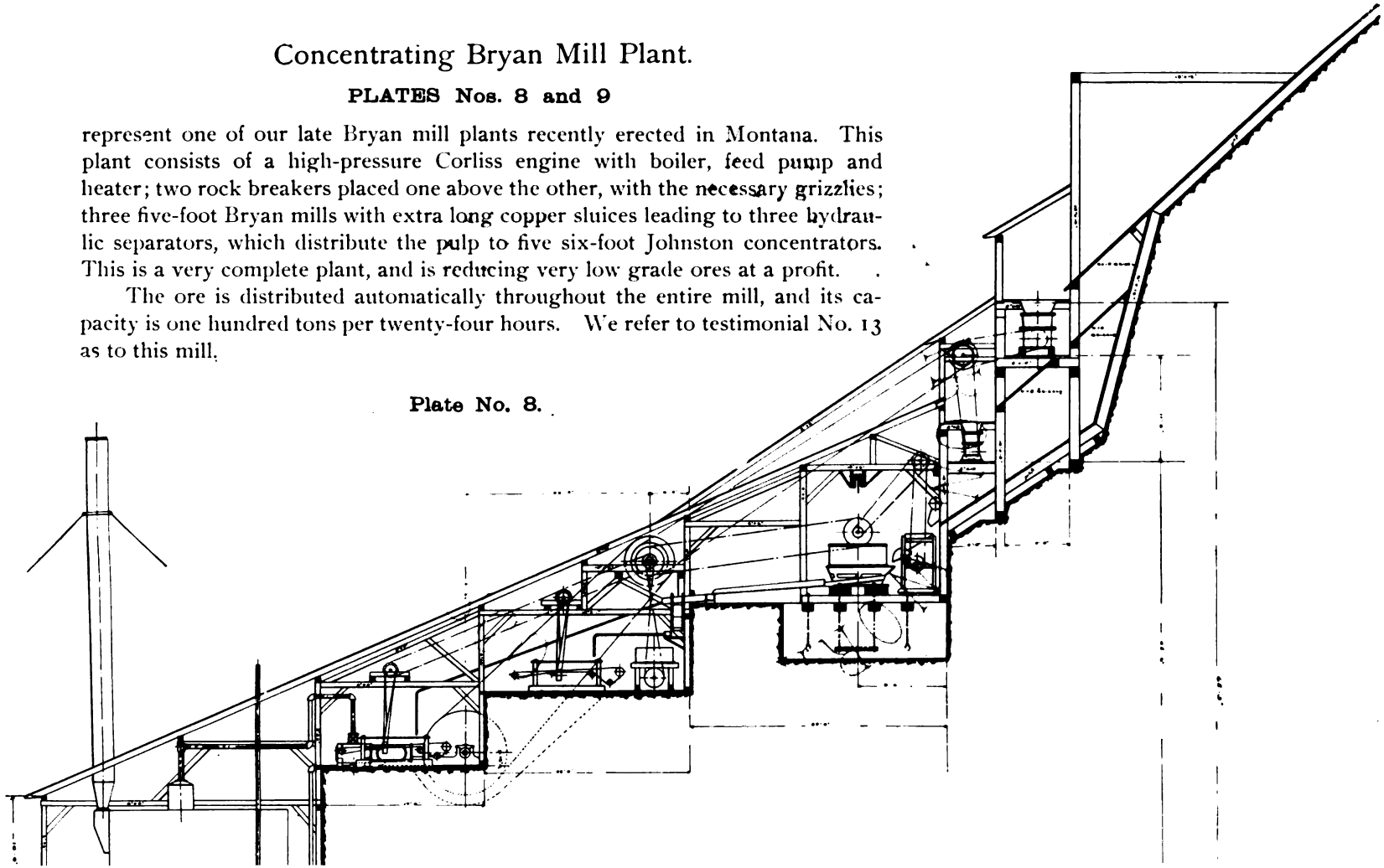
Concentrating Bryan Mill Plant.

PLATES Nos. 8 and 9

represent one of our late Bryan mill plants recently erected in Montana. This plant consists of a high-pressure Corliss engine with boiler, feed pump and heater; two rock breakers placed one above the other, with the necessary grizzlies; three five-foot Bryan mills with extra long copper sluices leading to three hydraulic separators, which distribute the pulp to five six-foot Johnston concentrators. This is a very complete plant, and is reducing very low grade ores at a profit.

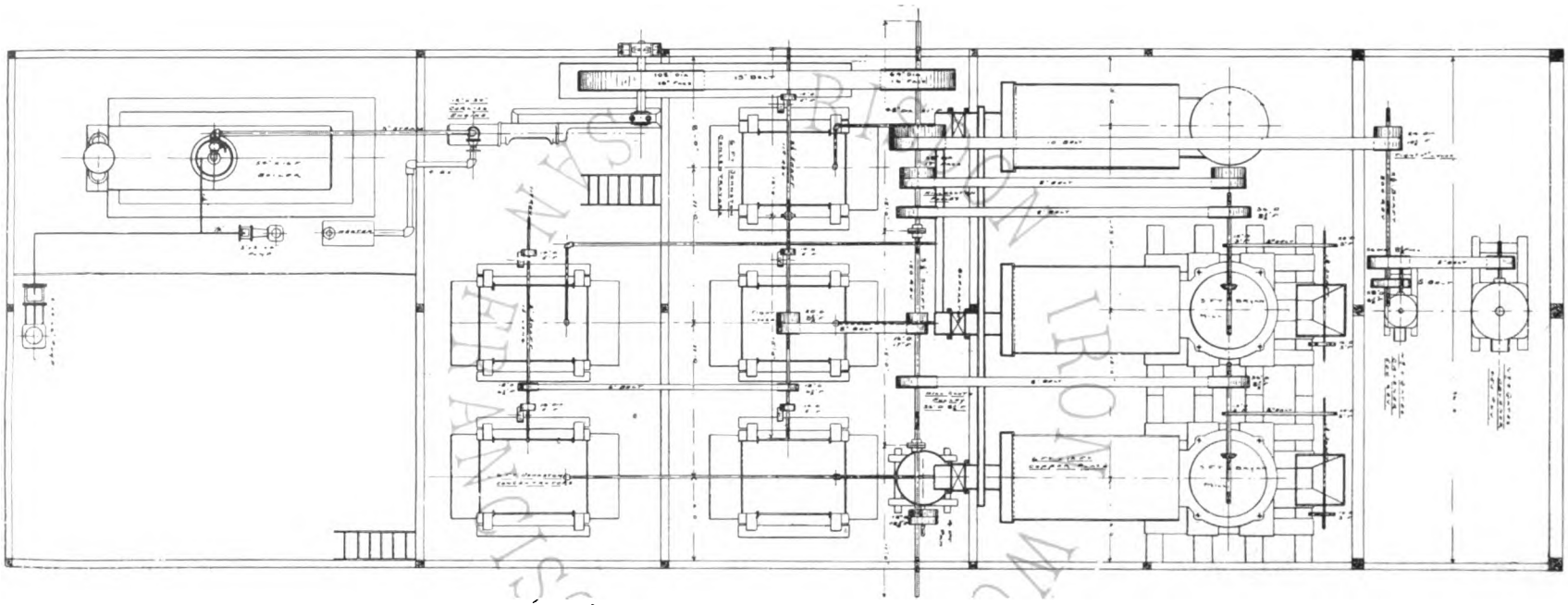
The ore is distributed automatically throughout the entire mill, and its capacity is one hundred tons per twenty-four hours. We refer to testimonial No. 13 as to this mill.

Plate No. 8.



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Plate No. 9.



Bryan Mill Plant

CONSISTING OF

3 Five-foot Bryan Mills.	2 Hydraulic Sizers.
5 Six-foot Johnston Concentrators.	1 Corliss Engine.
2 Rock Breakers.	1 Tubular Boiler.

Capacity ..... 100 tons per day.

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PLATE No. 10

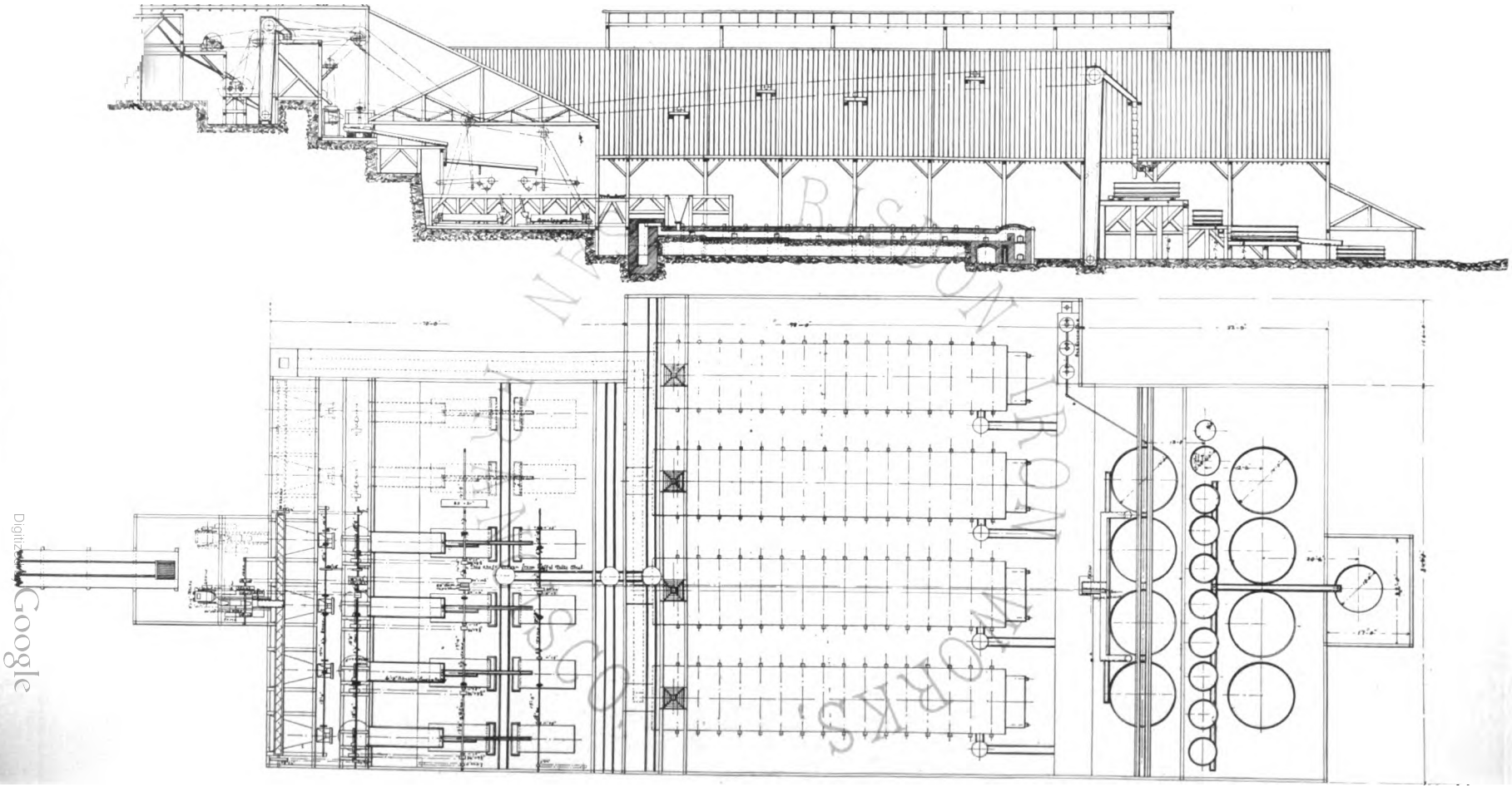
represents one of the most complete concentrating and chlorinating gold mills erected in this country, and is designed for a company operating in Idaho. It will be seen, from the cut of the elevation of the mill, that the ground is very flat, necessitating the elevation of the ore to facilitate handling. The ore is first received from a trestle work about fifteen feet from the ground, and is dumped through a pair of rock breakers, depositing it in an ore-bin, over two sets of Cornish rolls. It is then elevated by a bucket elevator and distributed by a screw conveyor to the ore bin over the six Bryan mills. From there it falls into the Bryan mills, where the pulp is discharged over a long copper sluice to twelve six-foot Johnston concentrators. The tailings from the concentrators run down through the concentrator floor to two revolving amalgamators, and then to cyanide tanks where the tailings are treated. The cyanide room extends the full width of the concentrator room.

The concentrates from the sulphurets are carried by a car to the draining platform, directly behind five reverberatory furnaces. When the sulphurets are sufficiently dry they are roasted in four 14 x 80-foot reverberatory furnaces, which have a capacity of six and one-half tons each.

The furnaces are discharged into a car, which is run in under the furnace. They are then placed again on the cooling floor; and, after being properly cooled, they are elevated by a bucket elevator and distributed into four chlorination tanks ready for gassing.

This is a most complete plant, the mill having a capacity of two hundred tons per twenty-four hours, and the chlorination works a capacity of twenty-five tons per twenty-four hours. It will be seen that this ore contains twelve and one-half per cent of sulphurets. Considering the difficulties in the way of handling the ore, the arrangement is a very good one.

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Bryan Mill Plant

CONSISTING OF

6 Five-foot Bryan Mills.
12 Six-foot Johnston Concentrators.
Capacity 200 tons ore per twenty four hours.

2 Rock Breakers.
2 sets Cornish Rolls.
Tailings worked by Cyanide and Revolving Amalgamators.
Capacity 25 tons sulphurets per twenty-four hours.

4 14 x 80-foot Reverberatory Furnaces.
Chlorination Plant of 25 tons capacity.

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Silver Mills.

Plates Nos. 10 and 11 illustrate a complete Bryan mill plant for the crushing of silver and gold ores. The plant is driven by steam power, consisting of compound slide-valve engine, with Meyers' cut-off and pair of horizontal tubular boilers, with the necessary feed pumps and heaters.

The ore is handled entirely by gravity, running from the grizzly to the rock breaker into the ore bin, and to the automatic feeders to four Bryan mills—either four or five foot,—from there over copper sluice to the pulp tanks, and then distributed to the eight amalgamating pans, which can be either the Combination or the Boss Continuous System; from there to four settlers. To the left, facing the Bryan mills, is the retort room, where a pair of 12 x 60-inch retorts and melting furnaces adjoin the assay room. This mill has been running for some time, and we refer to testimonial No. 14 as to its performance.

We have also built mills of this character to run entirely by water power; and further on in the catalogue we illustrate plant of this kind run by electric motors. This plant has a capacity with four four-foot Bryan mills of seventy-five tons per day, and, with five-foot, 150 tons per day, depending on the character of the ore.

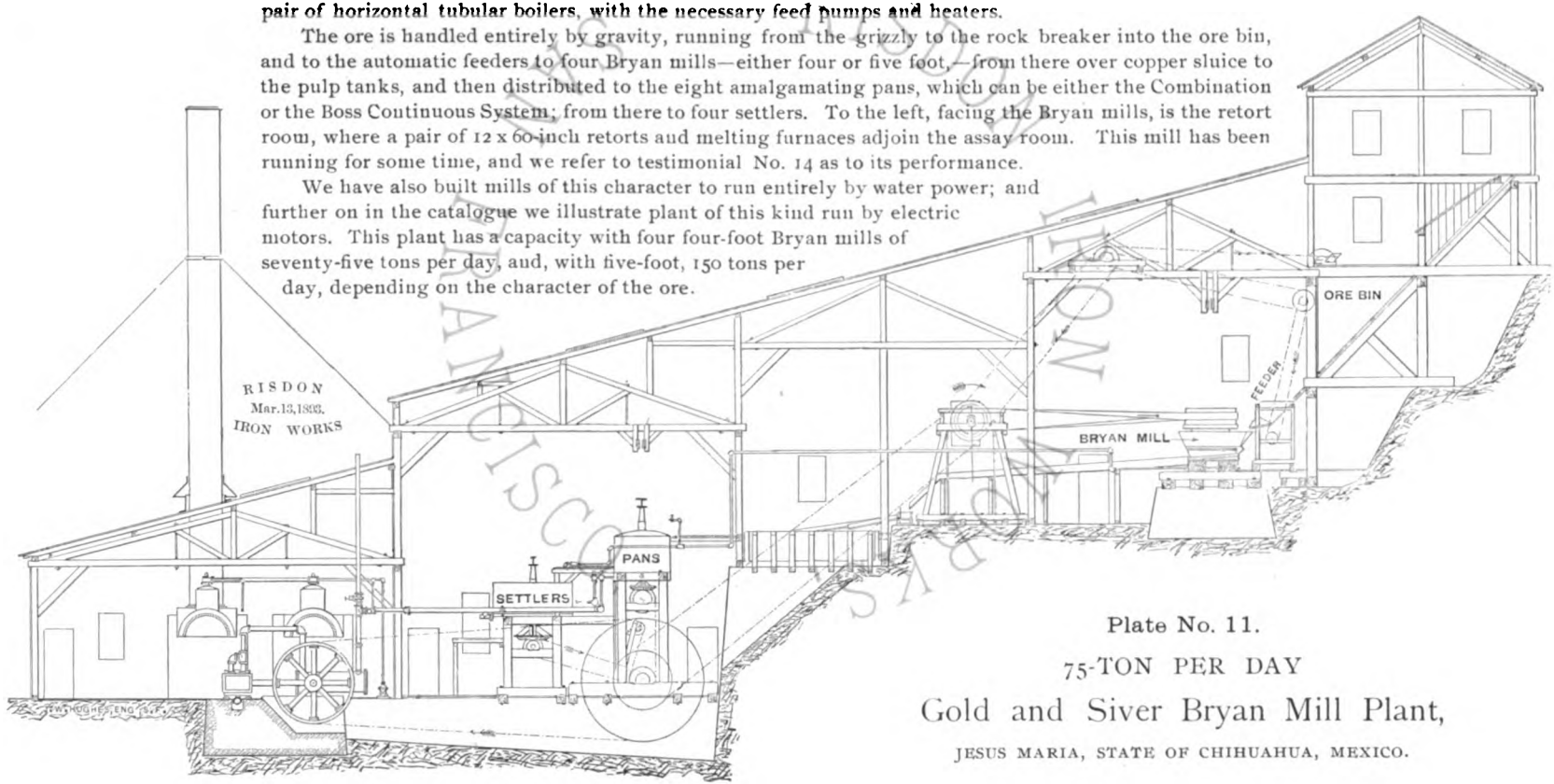


Plate No. 11.

75-TON PER DAY

Gold and Siver Bryan Mill Plant,

JESUS MARIA, STATE OF CHIHUAHUA, MEXICO.

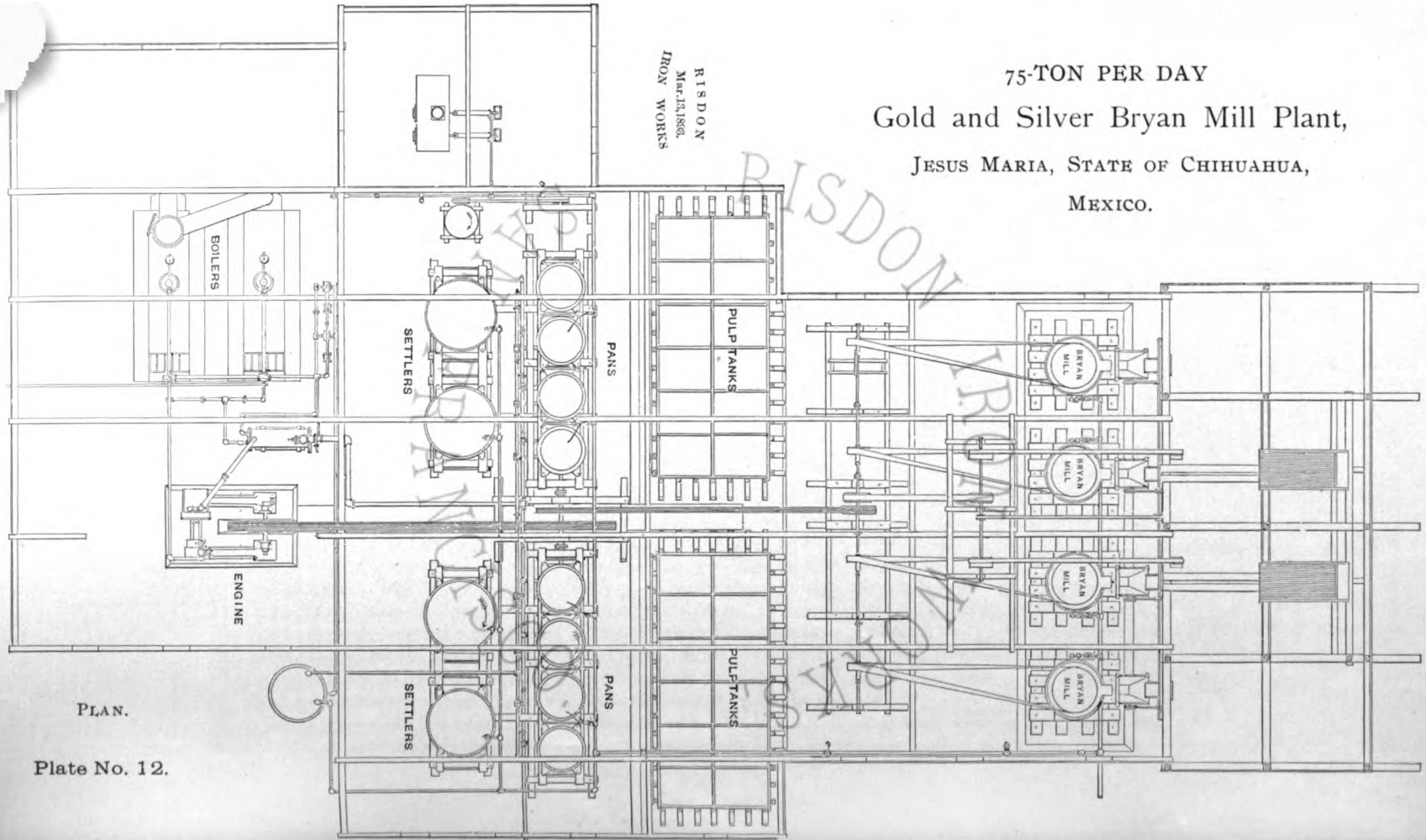
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75-TON PER DAY

Gold and Silver Bryan Mill Plant,

JESUS MARIA, STATE OF CHIHUAHUA,

MEXICO.



PLAN.

Plate No. 12.

RISDON IRON WORKS
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PLATES Nos. 13, 14 and 15

represent a very complete Bryan mill plant for free-milling silver and gold ores. The plant consists of three rock breakers, which deliver the pulp to ore bins above six Bryan mills. The pulp is then conveyed over copper sluice to pulp tanks to twelve five-foot amalgamating pans, which can be of the Combination or Boss Continuous Process; from there to six settlers. In the center between the two sets of settlers is the clean-up pan.

This mill is run by electricity;—one motor to run the rock breakers, and one to run the Bryan mills, and the third to run the pans and settlers.

To the left of mill, on level with settler floor, are the clean-up, retort and assay rooms.

This plant (with four-foot Bryan mills) will crush 125 tons of ore per day, and, with five-foot Bryan mills, 200 tons per day.

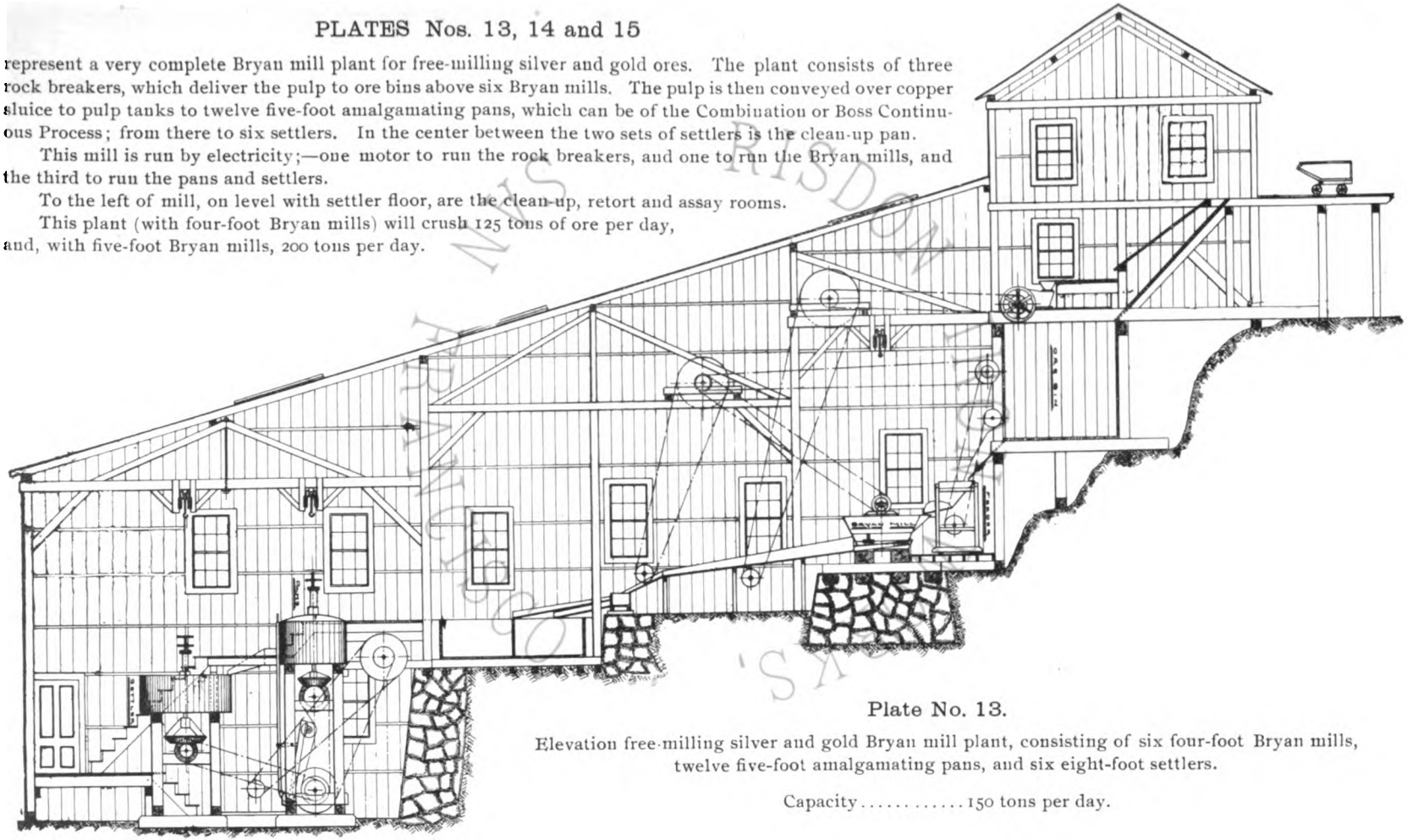


Plate No. 13.

Elevation free-milling silver and gold Bryan mill plant, consisting of six four-foot Bryan mills, twelve five-foot amalgamating pans, and six eight-foot settlers.

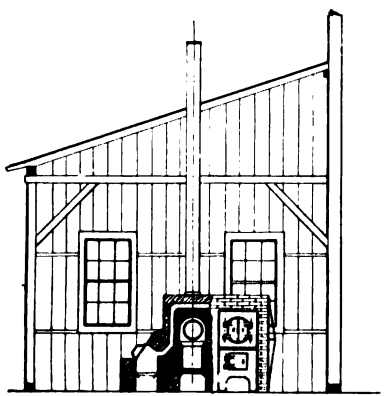
Capacity ..... 150 tons per day.

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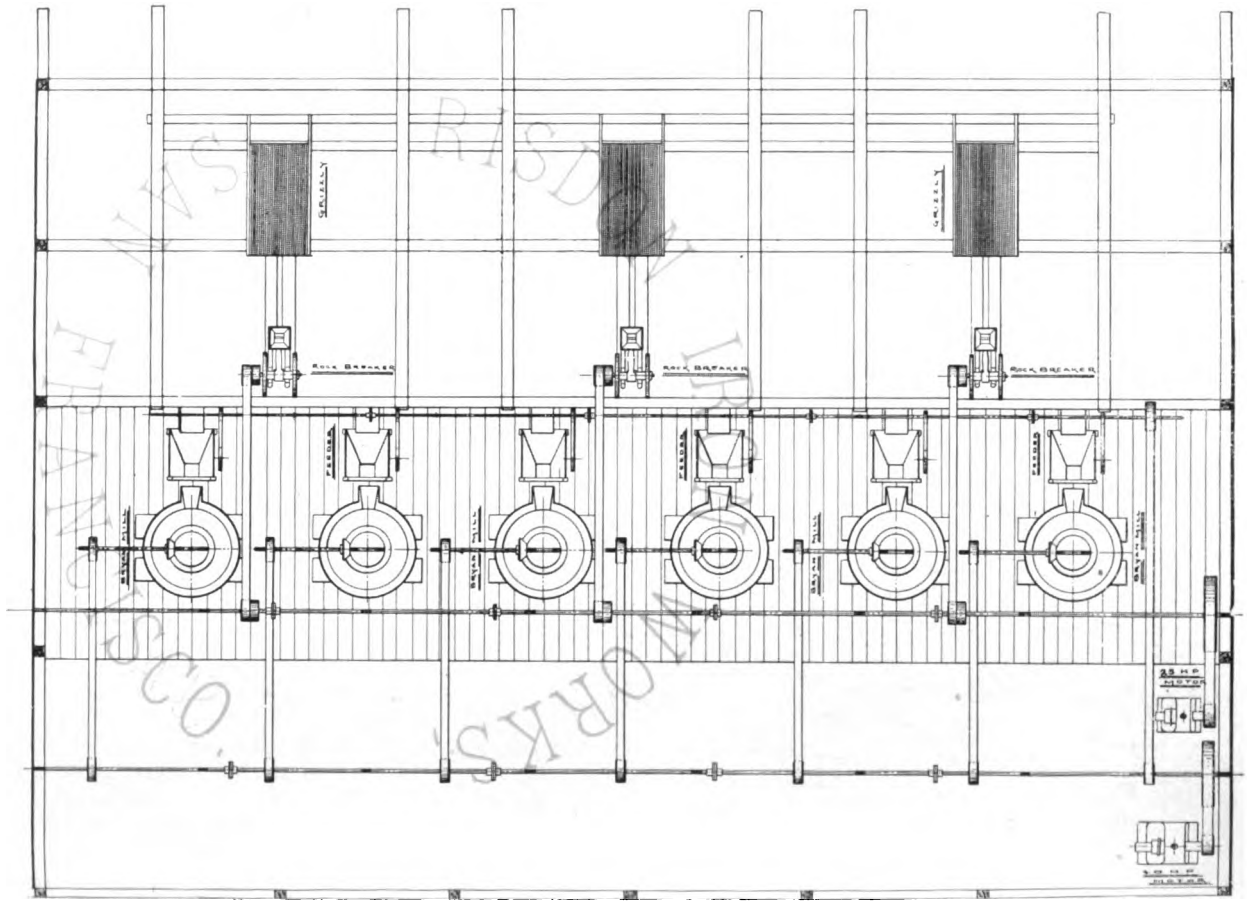
PLAN 6 BRYAN MILLS.

Free - milling Silver and Gold Bryan Mill Plant.

Capacity.... 150 tons per day.

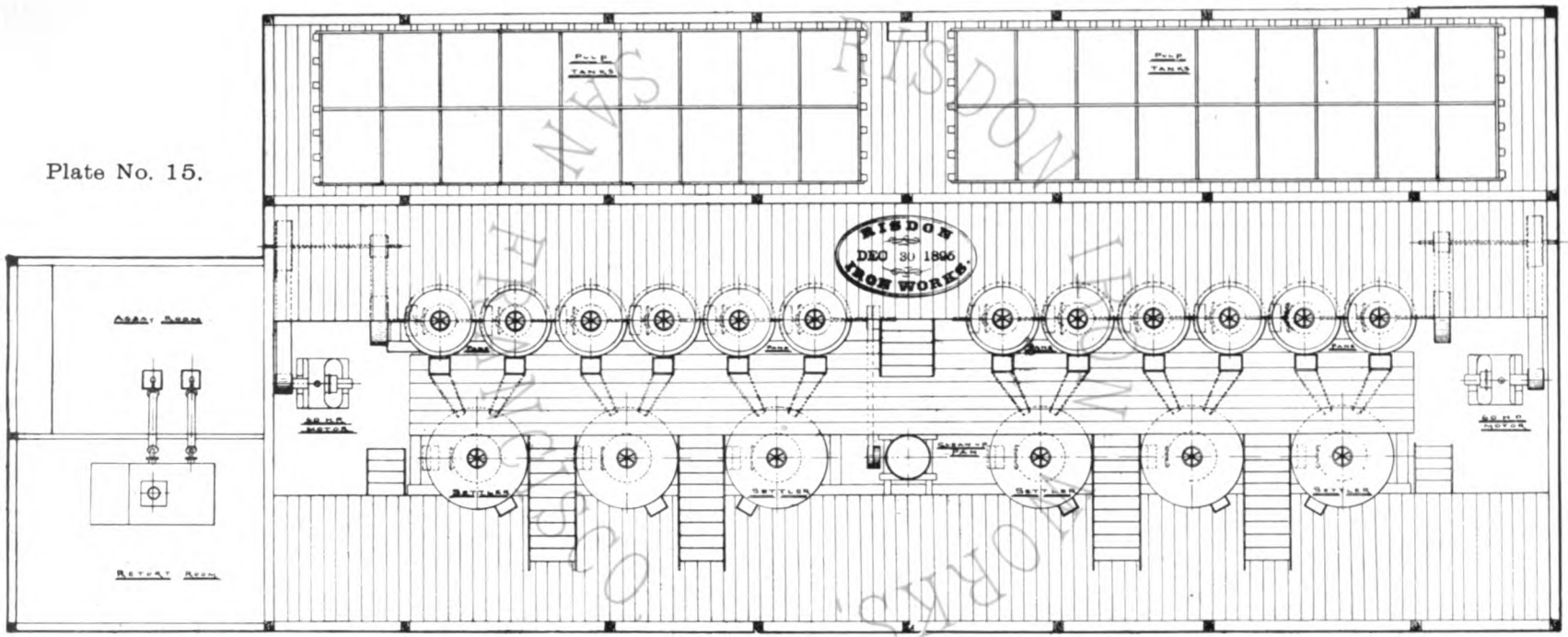


ELEVATION RETORT ROOM.



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Plate No. 15.


Pulp Tanks
Pulp Tanks
Assay Room
Retort Room
Settlers
Settlers
Settlers
Settlers
Sump Pit
Pans
Pans
Pans

Description of Concentrating Mills.

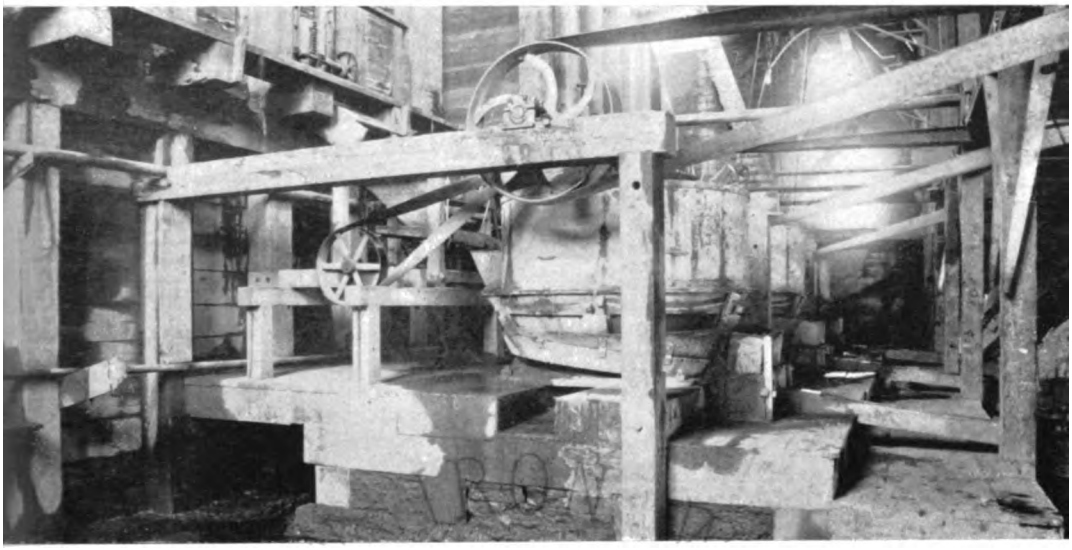
The following two half-tones represent the mill plant of the Bullion-Beck and Champion Mine, located at Eureka, Tintic District, Utah. In this plant we have three five-foot Bryan mills which take the jig middlings from the concentrator, regrinding them through a forty mesh screen and distributing the pulp to twelve six-foot Johnston concentrators. This plant handles one hundred tons of jig middlings per day; and the cost of wearing parts per ton of ore has been as low as seven (7) cents per ton.

The first Bryan mill placed in this plant was taken on trial to be run in a test with a mill of one of our competitors; and, after a four months' run, the Bryan proved its superiority to such an extent that two more were ordered; and the managers and owners of the mine are so thoroughly satisfied with its performance that we have placed several other mills for similar purposes.

This system of concentrating is largely in use throughout the mining countries where it is a difficult matter to handle the silver, lead, and other ores, on the ground, and the usual custom is to crush by means of rolls and rock breakers by screening through trommels, distributing the ore to Hartz or other jigs, thereby causing a separation of the heavier particles that can be shipped to advantage. This system leaves a large quantity of ore in the shape of tailings and middlings, which cannot be separated without further grinding. To do this, there have been tried at different times stamp mills and numerous other grinders, all without success. In stamp mills the slimes are so great that the values are entirely lost; but with the system in use at this mill—Bryan mills and Johnston concentrators being used—rock, which otherwise would be utterly worthless, is turned into a valuable product. The entire dump that laid for years in front of the Bullion-Beck Mine was run through the Bryan mills over our Johnston concentrators and turned into bullion at quite a profit to the company. This plant has been the means of calling our mill to the attention of mining men in the interior, as to what can be done with ores of too low a grade to work by any other process. We will take pleasure in designing plant to suit any conditions, either for milling or concentrating, and feel satisfied that the Bryan will give perfect satisfaction in every case.

The plant before described, we will take the liberty of giving a short description of, which may be of interest to our readers. We refer to plate No. 16 which gives an outside view of the mill building. The ore is raised from mine to mill in skips or self-dumping cars over an incline tramway about 650 feet in length with a grade of twenty-two degrees from horizontal. The skip's capacity is about 3,000 pounds, and is operated by an 8 x 12 double friction hoist, and dumps into a chute immediately above gyratory crusher. After passing this crusher, which reduces all the coarse material to a size that will pass a two and one-half-inch ring, the ore goes to a revolving grizzly three feet in diameter, eight feet long, covered with three-eighths perforated steel plate with one-inch holes, which removes the fine material, and the coarse goes to two Dodge rock breakers. These last two reduce it to the size that will pass a one and one-quarter-inch ring. It is then discharged, together with fine material, over revolving grizzly, into a three hundred ton storage bin immediately underneath the crushers. The rock breakers and hoist only run during daylight, in which time enough is crushed to keep the balance of the mill running for twenty-four hours. From the bin below the crushers the ore is drawn off into two ore feeders and fed to two sets of 16 x 36 plain double belt Cornish rolls, thence by elevator to roughing screen in upper part of mill. This screen is thirty inches in diameter, five feet long, covered with No. 3 mesh, No. 12 wire cloth;—under size going to sizing screen below, and over size to a third set of 16 x 36 rolls for finishing. We find it advantageous for repairs to have all our rolls of similar pattern and size, pasing from rolls to same elevator and returning to roughing screen. The No. 2 screen is same dimensions as No. 1, and is covered with No. 4 mesh, No. 12 wire cloth. Over size from this screen is feed for No. 1 jig; under size to No. 3 screen, which is covered with No.

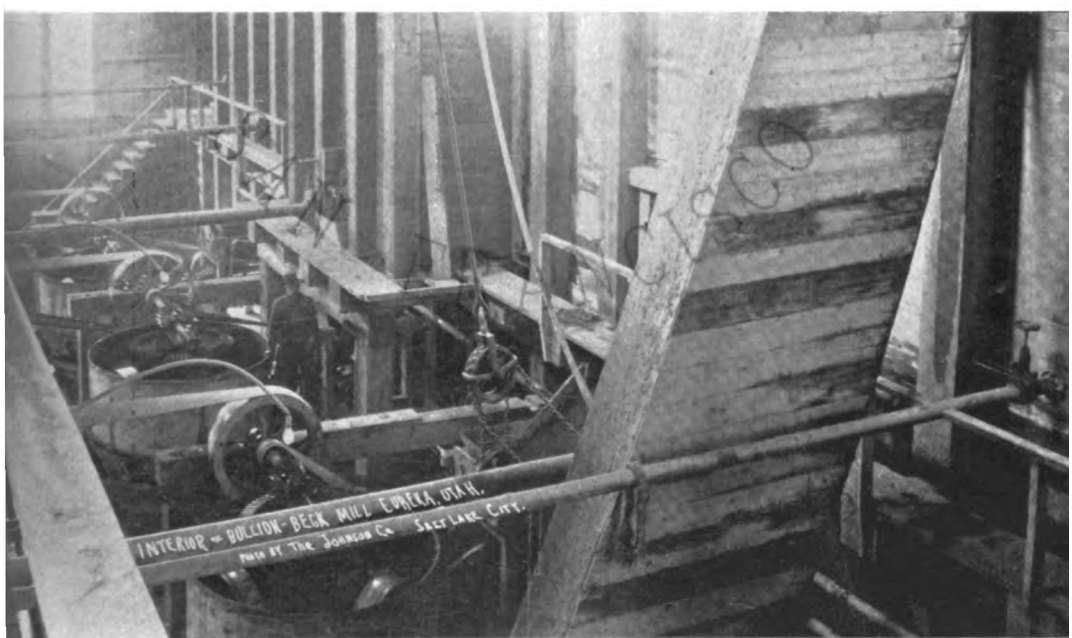
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3 Five-foot Bryan Mills

IN BULLION-BECK AND CHAMPION MINING CO'S MILL,

EUREKA, UTAH.



3 Five-foot Bryan Mills

IN BULLION-BECK AND CHAMPION MINING CO'S MILL,

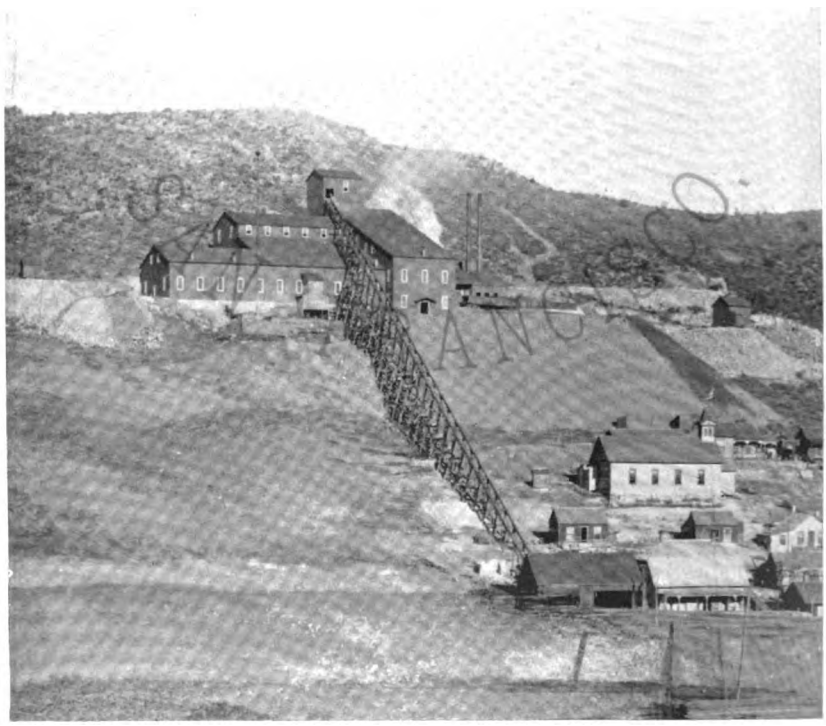
EUREKA, UTAH.

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6 mesh, No. 13 wire cloth. Over size from this screen to No. 2 jigs; under size of No. 4 screen covered with No. 8 mesh, No. 16 wire cloth. Over size from this screen to No. 3 jigs; under size to No. 5 screen, which is covered with No. 14 mesh, No. 20 wire cloth. Over size from this screen to No. 4 jigs; under size to hydraulic sizer, which removes coarser material for No. 5 jigs, and the under size to Johnston concentrators without further sizing.

They use three compartment Hartz jigs, with discharge for ore through hutch. For four of them on No. 1 size and two jigs on each of the other sizes, they make first-class product for shipping ore in first two compartments and a second class or middlings in the third. The first-class or shipping ore is discharged from the jigs to storage floor immediately under the jigs, and the second or middling is wheeled to elevator No. 2 which carries them to storage bins above, from which they are drawn through automatic feeders to the Bryan mills. At this point the pulp is reduced to No. 30 mesh, No. 29 wire screen, and is fed to the Johnston concentrators without further sizing for concentrating the fine slimes. Their ore consists of lead carbonates, carrying some gold and silver, with lime and quartz gangue, and approximate values are nine to ten ounces of lead, ten to twelve ounces of silver, and trace of gold. This is reduced in bulk to concentrates carrying 45 per cent lead, 35 ounces of silver, and .06 ounces of gold. This mill has been running for the past two years; and we append testimonials No. 1 and No. 2,—one after mills had been running six months, and the other after running two years.

Plate No. 16.



Bullion-Beck and Champion Mining Company's Mill,

EUREKA, UTAH.

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Specifications.

No. 1.

Four-foot Plain Gold Mill.

WATER POWER.

1 Four-foot Bryan Roller Quartz Mill.
1 Challenge Ore Feeder.
1 6 x 6 Dodge Rock Breaker.
1 18 x 24 Ore Bin Gate.
1 4 x 6 Grizzly (½-in. x 2½-in. Iron).
18 square feet Copper Plates, No. 12, 1 oz. Silver.
All necessary Shafting, Boxes and Pulleys for above.
All necessary Pipes and Fittings within the Mill.
All necessary Belting.

WATER POWER.

1 Ten-horse-power Water Wheel complete, with Gate, Nozzle, Shaft, Pulleys and Anchors.

No. 3.

Five-foot Plain Gold Mill.

STEAM POWER.

1 Five-foot Bryan Roller Quartz Mill.
1 Challenge Ore Feeder.
1 7 x 8 Dodge Rock Breaker.
1 18 x 24 Ore Bin Gate.
1 4 x 6 Grizzly (½-in. x 2½-in. Iron).
32 square feet Copper Plates, No. 12, 1 oz. Silver.
All necessary Shafting, Boxes and Pulleys for above.
All necessary Water Pipes and Fittings within Mill.
All necessary Belting.

STEAM POWER.

1 Fifteen-horse-power plain Slide Valve Engine (8-in. x 10-in. L. and S.).
1 Fifteen-horse-power Portable Boiler.
1 Feed Water Heater (Risdon box, 18 sq. ft.).
1 3 x 2 x 4-in. Feed Pump, Duplex.
All Steam and Water Pipes for above.

No. 5.

Five-foot Concentrating Gold Mill.

WATER POWER.

1 Five-foot Bryan Roller Quartz Mill.
1 Challenge Ore Feeder.
1 7 x 8 Dodge Rock Breaker.
1 18 x 24 Ore Bin Gate.
1 4 x 6 Grizzly (½-in. x 2½-in. Iron).
2 Johnston Concentrators 6 ft. (incl. royalty).
32 square feet Copper Plates, No. 12, 1 oz. Silver.
All necessary Shafting, Boxes and Pulleys for above.
All necessary Water Pipes and Fittings within the Mill.
All necessary Belting.

WATER POWER.

1 Fifteen-horse-power Water Wheel, with Gate, Nozzle, Shaft, Pulleys and Anchors.

No. 2.

Four-foot Plain Gold Mill.

STEAM POWER.

1 Four-foot Bryan Roller Quartz Mill.
1 Challenge Ore Feeder.
1 6 x 6 Dodge Rock Breaker.
1 18 x 24 Ore Bin Gate.
1 4 x 6 Grizzly (½-in. x 2½-in. Iron).
18 square feet Copper Plates, No. 12, 1 oz. Silver.
All necessary Shafting, Boxes and Pulleys for above.
All necessary Water Pipes and Fittings within the Mill.
All necessary Belting.

STEAM POWER.

1 Ten-horse-power plain Slide Valve Engine (7-in. x 10-in. L. & S.).
1 Ten-horse-power Portable Boiler.
1 Feed Water Heater (Risdon box, 18 sq. ft.)
1 3 x 2 x 4 Feed Pump.
All Steam and Water Pipes for the above.

No. 4.

Five-foot Plain Gold Mill.

WATER POWER.

1 Five-foot Bryan Roller Quartz Mill.
1 Challenge Ore Feeder.
1 7 x 8 Dodge Rock Breaker.
1 18 x 24 Ore Bin Gate.
1 4 x 6 Grizzly (½-in. x 2½-in. Iron).
32 square feet Copper Plates, No. 12, 1 oz. Silver.
All necessary Shafting, Boxes and Pulleys for above.
All necessary Water Pipes and Fittings within the Mill.
All necessary Belting.

WATER POWER.

1 Fifteen-horse-power Water Wheel, with Gate, Nozzle, Shaft, Pulleys and Anchors.

No. 6.

Five-foot Concentrating Gold Mill.

STEAM POWER.

1 Five-foot Bryan Roller Quartz Mill.
1 Challenge Ore Feeder.
1 7 x 8 Dodge Rock Breaker.
1 18 x 24 Ore Bin Gate.
1 4 x 6 Grizzly (½-in. x 2½-in. Iron).
2 Johnston Concentrators, 6 ft. (incl. royalty).
32 square feet Copper Plates, No. 12, 1 oz. Silver.
All necessary Shafting, Boxes and Pulleys for above.
All necessary Water Pipes and Fittings within the Mill.
All necessary Belting.

STEAM POWER.

1 Fifteen-horse-power plain Slide Valve Engine (8-in. x 10-in. L. & S.).
1 Fifteen-horse-power Portable Boiler.
1 Feed Water Heater (Risdon box, 18 sq. ft.)
1 3 x 2 x 4 Feed Pump.
All Steam and Water Pipes for the above.

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Specifications.

No. 7.

Four-foot Bryan Concentrating Gold Mill.

STEAM POWER.

1 Four-foot Bryan Roller Quartz Mill.
1 Automatic Ore Feeder.
1 Rock Breaker.
1 Ore Bin Gate.
1 Grizzly.
1 Johnston Ore Concentrator.
1 Ten-horse-power Engine and Boiler complete, with Pump, Heater, Pulleys, Bearings, Anchors, and all Pipes and connections for same.
18 square feet Electroplated Copper Plates.
All necessary Shafting, Boxes, Belts and Pulleys to drive Feeder.
All necessary Water Pipes and Fittings within the Mill.

No. 8.

Four-foot Bryan Concentrating Gold Mill.

WATER POWER.

1 Four-foot Bryan Roller Quartz Mill.
1 Automatic Ore Feeder.
1 Rock Breaker.
1 Ore Bin Gate.
1 Grizzly.
1 Johnston Ore Concentrator.
1 Ten-horse-power Pelton Water Wheel complete, with Gate, Nozzle, Shafting, Pulleys and Anchors.
18 square feet Electroplated Copper Plates.
All necessary Shafting, Boxes, Belts and Pulleys to drive Mill.
All necessary Water Pipes and Fittings within the Mill.

No. 9.

Four-foot Bryan Free-Milling Silver Mill.

WATER POWER.

1 Four-foot Bryan Roller Quartz Mill.
1 Automatic Ore Feeder.
1 Rock Breaker.
1 Ore Bin Gate.
1 Grizzly.
2 Five-foot Combination Pans, with Shafts and Gears.
1 Eight-foot Settler, with Shafts and Gears.
1 Four-foot Clean-up Pan, with Shafts and Gears.
1 Thirty-horse-power Pelton Water Wheel complete, with Gate, Nozzle, Shaft, Pulleys, Bearings and Anchors.
All necessary Pipes and Fittings within the Mill.
All necessary Shafting, Boxes and Pulleys.
All necessary Belting.
1 Retort, 10 inches diameter by 30 inches long, for Silver Amalgam.
1 Complete Ironwork for Bullion Melting Furnace.
1 Cast-iron Amalgam Safe, with Lock and Strainer.
1 Four-H. P. Boiler for heating Pans.

No. 10.

Four-foot Bryan Free-Milling Silver Mill.

STEAM POWER.

1 Four-foot Bryan Roller Quartz Mill.
1 Automatic Ore Feeder.
1 Rock Breaker.
1 Ore Bin Gate.
1 Grizzly.
2 Five-foot Combination Pans, with Shafts and Gears.
1 Eight-foot Settler, with Shafts and Gears.
1 Four-foot Clean-up Pan, with Shafts and Gears.
1 Thirty-horse-power Engine and Boiler complete, with Pump, Heater, Pulleys, Bearings, Anchors, and all Pipes and connections.
All necessary Pipes and Fittings within the Mill.
All necessary Shafting, Boxes and Pulleys.
All necessary Belting.
1 Retort, 10 inches diameter by 30 inches long, for Silver Amalgam.
1 Complete Ironwork for Bullion Melting Furnace.
1 Cast-iron Amalgam Safe with Lock and Strainer.

No. 11.

Five-foot Bryan Free-Milling Silver Mill.

WATER POWER.

1 Five-foot Bryan Roller Quartz Mill.
1 Automatic Ore Feeder.
1 Rock Breaker.
1 Ore Bin Gate.
1 Grizzly.
4 Five-foot Combination Pans, with Shafts and Gears.
2 Eight-foot Settlers, with Shafts and Gears.
1 Four-foot Clean-up Pan, with Shafts and Gears.
1 Fifty-five-horse-power Water Wheel complete, with Gate, Nozzle, Shaft, Pulleys, Bearings and Anchors.
All necessary Water Pipes and Fittings within the Mill.
All necessary Shafting, Boxes and Pulleys.
All necessary Belting.
1 twelve inches diameter by 48 inches long Retort for Silver Amalgam.
1 Complete Ironwork for Bullion Melting Furnace.
1 Cast-iron Amalgam Safe, with Lock and Strainer.
1 Six-horse power Boiler for Heating Pans.

No. 12.

Five-foot Bryan Free-Milling Silver Mill.

STEAM POWER.

1 Five-foot Bryan Roller Quartz Mill.
1 Automatic Ore Feeder.
1 Rock Breaker.
1 Ore Bin Gate.
1 Grizzly.
4 Five-foot Combination Pans, with Shafts and Gears.
2 Eight-ft. Settlers, with Shafts and Gears.
1 Four-foot Clean-up Pan, with Shafts and Gears.
1 Fifty-five-horse-power Engine and Boiler complete, with Pump, Heater, Pulleys, Bearings, Anchors, and all Pipes and connections for same.
All necessary Water Pipes and Fittings within the Mill.
All necessary Shafting, Boxes and Pulleys.
All necessary Belting.
1 twelve inches diameter by forty-eight inches long Retort for Silver Amalgam.
1 Complete Ironwork for Bullion Melting Furnace.
1 Cast-iron Amalgam Safe with Lock and Strainer.

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Testimonials.

(1)

Bullion-Beck and Champion Mining Co.

Eureka, Utah, August 24, 1895.

The Risdon Iron and Locomotive Works, San Francisco:

Gentlemen: Referring to contract made by you with the Bullion-Beck and Champion Mining Company, by which you were to furnish one five-foot Bryan roller quartz mill on four months' trial, in competition with the Huntington mill, would say that we have made the test, and the Bryan mill has proved so greatly superior on all points claimed, viz, capacity and economy, that we have ordered a second Bryan mill from you, and have concluded to discontinue the use of the Huntington mill.

Yours truly,

JOHN BECK, President.
SIMON BAMBERGER, Director.
W. J. BEATIE, Secretary.

(2)

Bullion-Beck and Champion Mining Co.

Eureka, Utah, Sept. 1, 1896.

The Risdon Iron Works, San Francisco:

Gentlemen: Replying to yours of the 29th of August, will state that we have three of your five-foot Bryan mills in operation at the concentrator; and have no hesitancy in saying that for the class of work we have put on the mills, that is, pulverizing middlings from jigs, there can be no more satisfactory machine built in point of economy, both of wear and tear, and small amount of attention required in operation. If given a regular feed and the proper flow of water, they require no attention other than to oil once in three or four hours and replace broken screens when necessary.

We are running twenty-five to thirty-five tons per day to each machine; use No. 30 mesh screen; two screens to each mill. A set of tires lasts five to six months, dies two to three months, set screens two to four days.

Yours very truly,

(Signed) ED. X. KIRBY,
Sup't B.-B. and C. Mining Co.

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(3)

Tepic, April 2, 1891.

Risdon Iron and Locomotive Works, San Francisco:

Gentlemen: I take this opportunity to state that for the ores of the "Castellana" Mine your mill does excellent work; having also the great advantage for places situated at distances from workshops that can be attended to by persons not having much mechanical skill. I have recently ordered another mill for the San Sebastian Mines called "Jalisco," and I trust to observe the same favorable results for crushing those ores, which, however, are of a different nature.

Yours truly,

(Signed) ALFRED LONERGAN.

[FIVE YEARS LATER.]

(4)

Lonergan y Stanhope, Tepic, Mexico.

Ixtlan del Rio, Tepic, Mexico, Sept. 16, 1896.

The Risdon Iron and Locomotive Works, San Francisco, Cal.:

Dear Sirs: On my arrival here yesterday I found your favor dated 28th ult., and have pleasure in replying thereto. In the Castellana Mines, two No. 4 sectional Bryan mills are working and have been working for over five years. In the Jalisco Mining Company's Mill, at San Sebastian, two mills of same dimensions are likewise at work. All obtained from your works.

I am able to state that these have given complete satisfaction, crushing through a forty mesh screen on an average of from ten to eleven tons in twenty-four hours, and through a sixty mesh screen from nine to ten tons in twenty-four hours.

The principal attraction these mills have is the great facility for keeping them in repair in places where skilled mechanical labor is extremely scarce, as is the case in the mining districts of these parts of Mexico.

You are perfectly at liberty to insert all or any part of this letter as a testimonial to any of your customers. Yours very truly,

(Signed) ALFRED LONERGAN.

(5)

R. N. Dickman, a mining expert of Cleveland, Ohio, who has just returned from a visit to all the mining districts of Sonora and Chihuahua, Mexico, speaking to a party of friends the other evening, said: "I always thought that stamps were the best pulverizers for milling ores; but, since I have seen the four Bryan mills of the Santa Eduwiges Company in operation at Jesus Maria, I am convinced that that machine is the best pulverizer for hard ores,—one of these mills having made a record of twenty-two (22) tons through forty mesh screens in twenty-four hours." (Extract from Mexican papers.)

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(6)

The Guggenheim Smelting Company.

Perth Amboy, N. J., September 22, 1896.

The Risdon Iron and Locomotive Works, San Francisco, California:

Gentlemen: In response to your request, I am pleased to state that, from my experience in Gibbonsville, Idaho, last year, I can highly recommend the work performed by the Johnston concentrator, both as to saving of values as well as to capacity. The concentrates were clean, and the tailings from $25.00 gold ore showed only traces of gold, though the ore was inclined to slime. Let me add that such good work was partly due to the Bryan mills, which prepare the ore for plate-amalgamation, and following concentration far better than any other roller mill, or a stamp battery. The wear and tear on Bryan mills is exceedingly low compared with other grinding mills, not to speak of stamps.

Very truly yours,

(Signed) OSCAR SZONTAGH, Superintendent.

Care Guggenheim Smelting Company, Perth Amboy.

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(7)

Baker City, Oregon, March 22, 1891.

Risdon Iron Works, San Francisco, Cal.:

Dear Sirs: The five-foot Bryan mill you furnished for the Elkhorn Mining Company, in 1890, has been running regularly, and has given excellent satisfaction.

As an amalgamator of gold the Bryan mill has no equal. It has really astonished those who have seen its work. It has saved more gold from our heavy sulphureted ore than I had believed it possible, and more than any other mill can save.

ELKHORN MINING COMPANY,

J. H. ROBBINS, President.

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(8)

[FIVE YEARS LATER.]

McCoy, Oregon, September 1, 1896.

Risdon Iron and Locomotive Works:

Gentlemen: The five-foot Bryan mill you shipped us five years ago has given us the best satisfaction as a pulverizer and amalgamator. I do not think it can be beat. It makes no slimes, and will free the gold in base ore to so great an extent that it will amalgamate.

I am aware that many people are prejudiced in favor of stamps; but the Bryan mill, properly managed, is better than stamps or any other quartz mill that ever was invented.

Respectfully,

ELKHORN MINING COMPANY,

(Signed) J. H. ROBBINS, President.

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(9)

Negociacion Minera del Promontorio.
Promontorio, Durango, Mexico.

Gentlemen: Your favor of 10th inst. is at hand. Regarding the Bryan mill, would say that we crush with a four-foot mill through a forty mesh screen an average of fifteen to eighteen tons of quartz ore in twenty-four hours.

My experience teaches that the Bryan does the best work on hard ores of any mill, and you will always be safe in recommending its use.

Yours truly,

(Signed) ARTHUR BUETTNER, Superintendent.

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(10)

Office of the Candelaria Consolidated Mexican Mining Co.
San Dimas, Durango, Mexico, October 25, 1888.

Risdon Iron Works, San Francisco:

Gentlemen: Our company has been operating three of the four-foot Bryan roller quartz mills, one of which has been running steadily for three years, one for two and one for one year. Our quartz is very hard; we crush through a No. sixty mesh screen. Our mills run fifty-five revolutions per minute, and each crush through sixty mesh screens twelve tons in twenty-four hours; through fifty mesh, fifteen tons; and through forty mesh, eighteen tons. This proportion has been continuous.

One set of dies will crush from 1,500 to 1,600 tons.

One set of tires will crush 1,500 tons.

One ring plate will crush from 2,200 to 2,300 tons.

The mills require very little attention. At our mill an ordinary *peon* earning one dollar per day has complete charge.

In regard to sliming, in comparison with stamps by reason of the discharge surface and the continuous agitation by the scrapers, a *much* less amount of slime is created. A three years' experience teaches me that, in every respect, the mills are a complete success, and of material benefit to the mining world. They can be set up and running in forty-eight hours, and can be dismounted in the same time and removed to wherever desired. Ours were packed on our mule trail over as difficult a road as any in Mexico. As a gold amalgamator it is unequaled by any mill now in existence.

Yours truly,

D. M. BURNS, Superintendent.

[TEN YEARS AFTER FIRST MILL STARTED.]

October 1, 1895.

Our mills are still doing splendid work, and I take pleasure in recommending them.

D. M. BURNS, President.

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(11)

Gilmore Mine, Virginia, July 21, 1888.

Risdon Iron Works, San Francisco, California:

Gentlemen: I have been running one of your four-foot Bryan roller quartz mills for about a year on very hard gold quartz. We are running the mill at forty-eight revolutions per minute, and are pulverizing, through a fine thirty mesh wire screen, between nine to ten tons per day of ten and one-half hours. On softer ore I have pulverized as high as twenty tons per day of eleven hours, and amalgamated sixty-eight per cent inside of battery. We are still using the original tires and dies which came with the mill. Tires are yet one inch thick, ring one-half inch, and dies are three inches thick. With the exception of new screens and rebabbitting the drum around the center post, we have had no repairs to cost anything. Any parties wishing to see a splendid pulverizer at work, or a complete mill, may be referred to me at the Gilmore Mill, of which I have charge.

Yours very truly,

T. RUSSELL WILLARD, Columbia, Va.

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(12)

Little Kid Mine, Norris, Montana, October 9, 1896.

The Risdon Iron Works, San Francisco:

Gentlemen: I take pleasure in informing you that the five-foot concentrating Bryan mill plant erected at the Little Kid Mine for me last year has given entire satisfaction. Both the Bryan mills and Johnston concentrators are all that you represent them, and I am more than pleased with the results obtained, and have no hesitancy in recommending your mills.

Your truly,

JOHN McKELVEY.

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(13)

Extract from letter from Professor J. H. Kerr, York, Montana, Old Amber Reduction Works, dated March 10, 1896:

"We have started up our Bryan mill plant and take pleasure in informing you that it is running fully up to my expectations. We have seen your mills in operation in Mexico several years ago; and, at that time, I made up my mind that they were the most economical mills for crushing ore I know of.

"Your mills here are crushing about thirty-five tons per day through a forty mesh screen and giving every satisfaction.

"The Johnston concentrators are doing excellent work, and I take pleasure in recommending them."

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(14)

Santa Eduwiges Company, State of Chihuahua,
Jesus Maria, Mexico, October 1, 1893.

Risdon Iron and Locomotive Works, San Francisco, Cal.

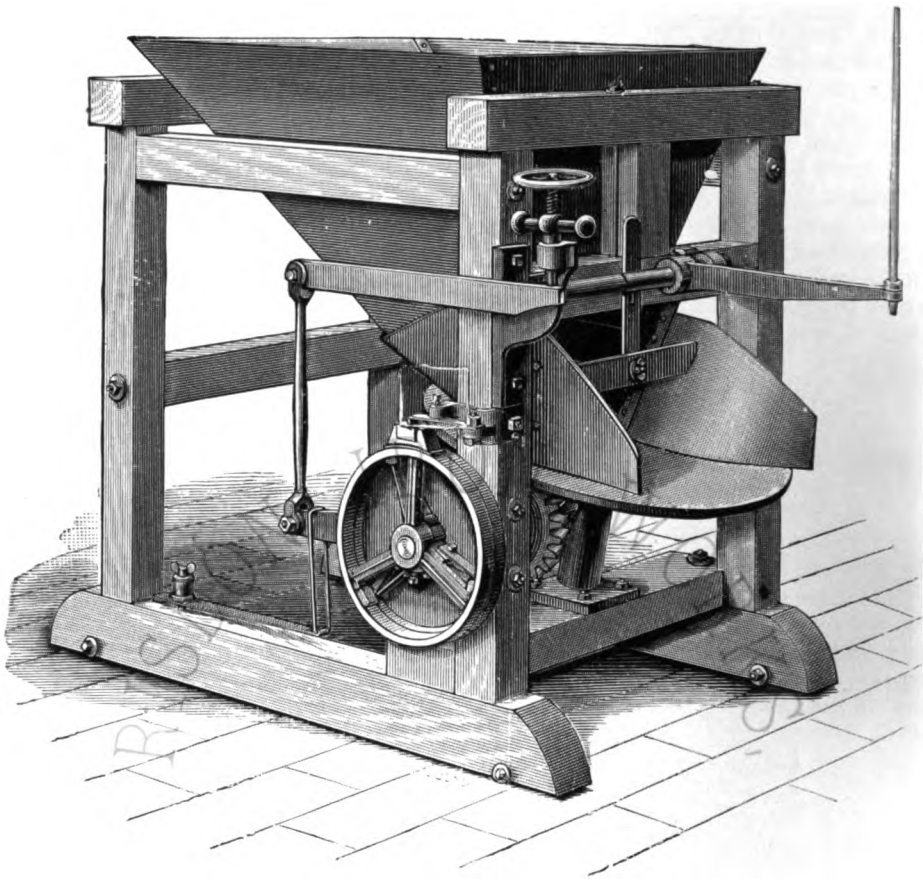
Gentlemen: Having completed the erection of the silver and gold amalgamating plant furnished us by you, I take pleasure in announcing to you that it is completely satisfactory in every particular. The 4 four-foot Bryan mills are doing excellent work and seem to suit our ore; their capacity is not overestimated, and I consider them the best pulverizer made for wet crushing.

Sincerely yours,

(Signed) H. A. W. TABOR.

H. A. W. TABOR, President. CARLOS M. SIQUEIROS, Supt of Mine.
JUAN S. HART, General Manager. TOMAS SIQUEIROS, Cashier.

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Risdon Challenge Ore Feeder.

When batteries were fed by hand, it required the labor of three men to feed twenty stamps twenty-four hours.

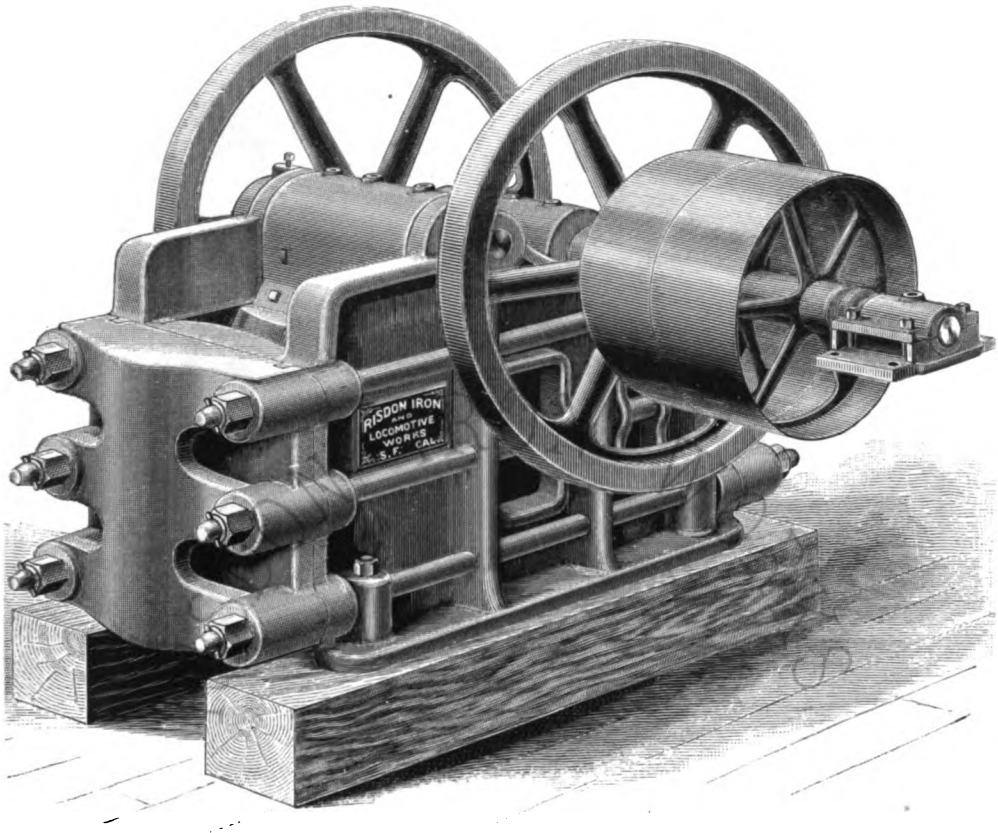
Now four automatic ore feeders perform the same work (with an occasional visit from the batteryman), increasing the capacity of the battery from ten to twenty per cent over hand feeding; at the same time saving considerable loss from breakage of screens and stamps, resulting from the inattention of hand feeders.

It is evident that the ore feeder occupies a very important place in a quartz mill, and that it is also important to have a feeder which can be relied upon to feed the required amount of ore to the battery at the proper time, whether the ore happens to be wet or dry, sharp hard ore, or mixed with clay and moisture.

These feeders are in use in nearly all the leading mining districts, and are considered a standard feeder.

Shipping weight..... 750 lbs.
Price $100 00

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The Improved Blake Rock Breaker.

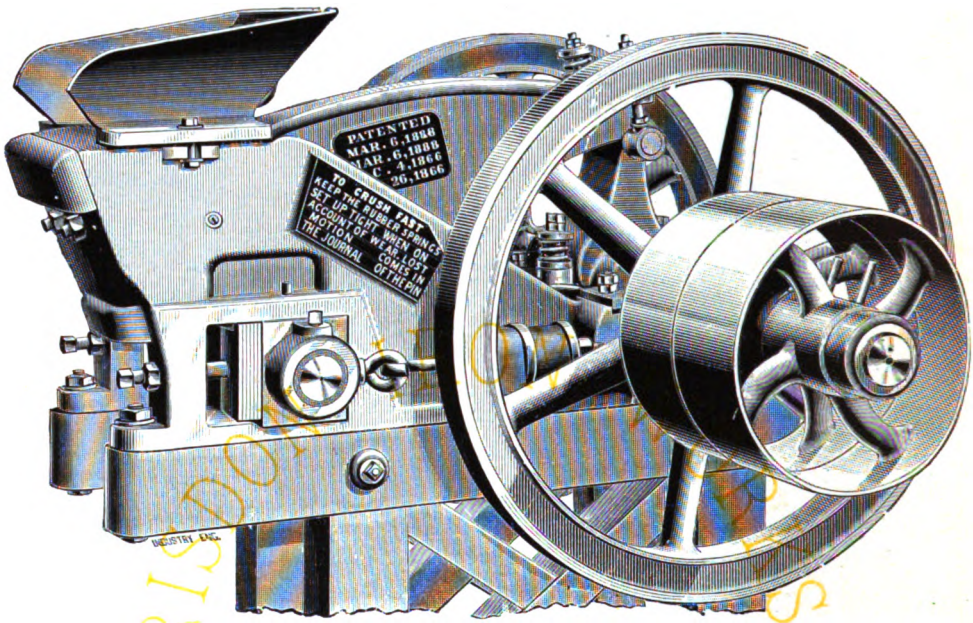
We illustrate above an improved and simplified form of the well-known Blake rock breaker. This machine is too well known to require extended notice. The bolts which take the crushing strain pass outside of side frames and run the whole length of the machine, thus making the frame very strong and rigid. Two pull back springs are provided instead of one, thus giving a better effect and reducing liability to breakage. The shoe, die and toggle seals are made of cast steel, and eccentric shaft of forged steel. The design, metal and proportions throughout have been determined from actual practice, and with the other improvements make this an unusually strong and efficient machine.

TABLE OF STANDARD SIZES.

Size No.	Jaw Opening for Receiving Rock.	Capacity in tons per hour, Jaws Set 1½"	Extreme Dimensions. Length ft.	in.	Bre'dth ft.	in	Driving Pulley. Diam., in	Face, in.	Weight Heaviest Piece.	Weight Complete.	Horse-power Required.	No. Revolutions per Minute.	Price.
1	7 x 9	4	4	2	3	6	20	6½	300	2,700	4	275	$ 300
2	8 x 12	6	5	0	4	0	24	8½	500	4,900	5	250	500
3	9 x 15	10	5	8	5	0	30	8½	1,150	8,000	8	250	800
4	13 x 18	15	9	0	7	6	36	10½	2,900	25,000	20	200	2,400

No. 2 made in 300-pound sections; $50.00 extra.

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Dodge Improved Rock Breaker.

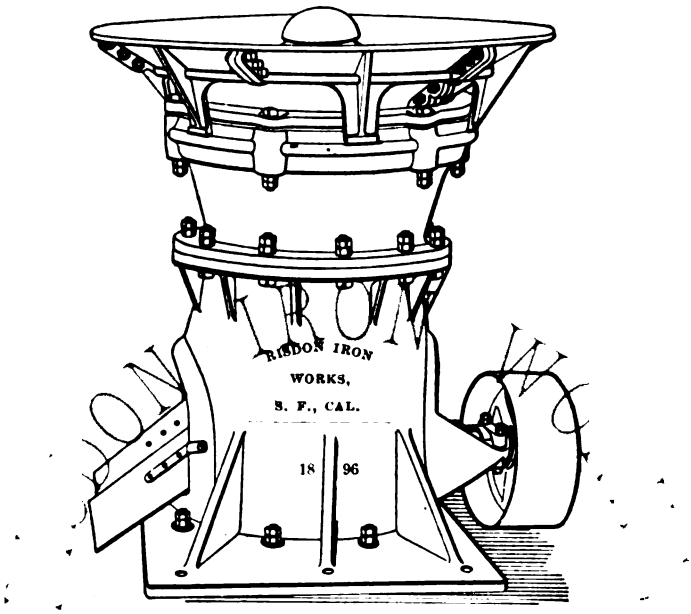
No.	Size.	Capacity	Weight of Heaviest Piece.	Total Weight.	Extreme Dimensions. Length.		Breadth		Height.		Driving Pulleys, Tight and Loose. Diam.		Face.		Proper Speed.	Horse-power.	Price.
					Ft.	In	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.			
1	8 x 12	4 to 6 tons per hour, or twenty stamps. . . .	2,100	4,600	4	6	5	3	4	0	2	0	0	8	250	7	$500 00
2	7 x 8	3 to 4 tons per hour, or ten stamps.....	912	2,200	3	9	3	7	3	0	1	4	0	6	300	5	300 00
3	6 x 6	1 to 2 tons per hour, or five stamps.....	360	1,200	3	0	3	0	2	0	1	0	0	5	350	3	150 00

This breaker should be ordered when fine crushing is desired. Our system of construction provides in this breaker for ready, positive adjustment for finer or coarser particles as desired. We make No. 2 breaker in sections so that it can be carried on mules. No. 3 can also be packed. We carry all the above sizes in stock, and are prepared to furnish them at short notice.

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"Risdon" Gyratory Crusher.

GREATEST ON EARTH.



PRICES, DIMENSIONS, WEIGHTS, CAPACITIES AND REQUIRED POWER.

Size.	Dimensions of each receiving opening, about. Inches.	Dimensions of three receiving openings combined, about. Inches.	Weight of Breaker. Pounds.	Capacity per hour, in tons of 2,000 lbs., passing 2½ in. ring, according to character of rock or ore.	Dimensions of Driving Pulley. Diam., inches.	Face, inches.	Revolutions of Driving Pulley.	Size engine recommended to drive breaker, elevator and screen. Indicated Horse-power.	Prices subject to change without notice.
00	2 x 4	2 x 12	350	.....	8	2⅝	700	1 to 1½	$ 100
0	4 x 10	4 x 30	3,000	2 to 4	16	6	500	4 " 5	375
1	5 x 12	5 x 36	5,500	4 " 8	20	7	475	8 " 10	550
2	6 x 14	6 x 42	8,000	6 " 12	24	8	450	12 " 15	760
3	7 x 15	7 x 45	14,000	10 " 20	28	10	425	20 " 25	1,200
4	8 x 18	8 x 54	21,000	15 " 30	32	12	400	25 " 30	1,800
5	10 x 20	10 x 60	29,000	25 " 40	36	14	375	30 " 40	2,500
6	11 x 24	11 x 72	40,000	30 " 60	40	16	350	40 " 60	3,300
7½	14 x 30	14 x 90	61,000	50 " 125	44	18	350	75 " 125	5,000
8	18 x 42	18 x 126	90,000	100 " 150	48	20	350	100 " 150	7,000

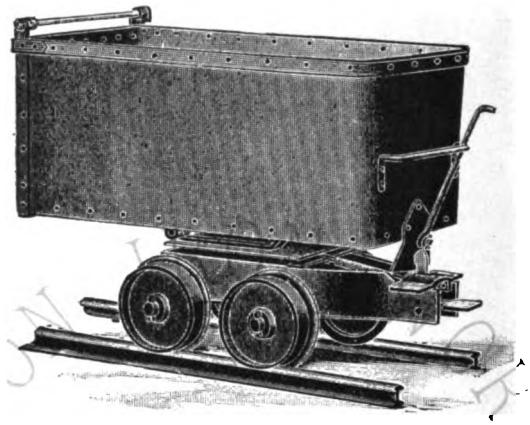
The above prices do not include foundation bolts.

The mechanical construction of this form of Risdon breaker is without doubt the finest ever made. It is a breaker of the gyratory form. The word gyatory partially explains the mechanism. The crushing is done between a cone placed on a gyratory shaft vertical through the center of a cylindrical shell. As it gyrates, the crushing cone impinges against the sides of the shell, in relation to which it is constantly approaching and receding. The top of the shaft carrying the crushing cone is held rigidly, while the bottom is gyrated (with a certain amount of eccentricity depending upon the size of the machine) by means of a simple gearing.

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RISDON IRON AND LOCOMOTIVE WORKS,

SAN FRANCISCO, CAL.



Steel Mining Cars.

NO.	DIMENSIONS IN INCHES.			THICKNESS.		CAPACITY.	Diameter of Wheels.	Weight	SIZE AXLE.	PRICE.
	Width.	Depth.	Length	Sides.	Bottoms.	Cubic Feet.			Diam.	
1	16	18	30	14	14	5	8	310	1¼	$ 38
2	18	24	36	14	12	9	10	350	1¼	40
3	24	21	44	14	12	12	10	380	1¼	45
4	24	21	44	12	12	12	10	420	1¼	50
5	24	21	44	12	10	12	10	475	1¼	60
6	22	24	40	12	10	12	10	600	1½	72
7	24	24	42	12	10	14	10	650	1½	80
8	24	25	48	6	4	16	12	590	1½	75
9	26	24	44	6	4	16	12	700	2	84
10	26	24	48	6	4	17½	12	750	2	90
11	30	25	48	4	4	20	12	685	2	85
12	28	26	48	4	4	20	12	800	2	96
13	30	26	54	4	4	22½	12	850	2	100
14	36	30	72	4	4	45	12	1500	2½	175

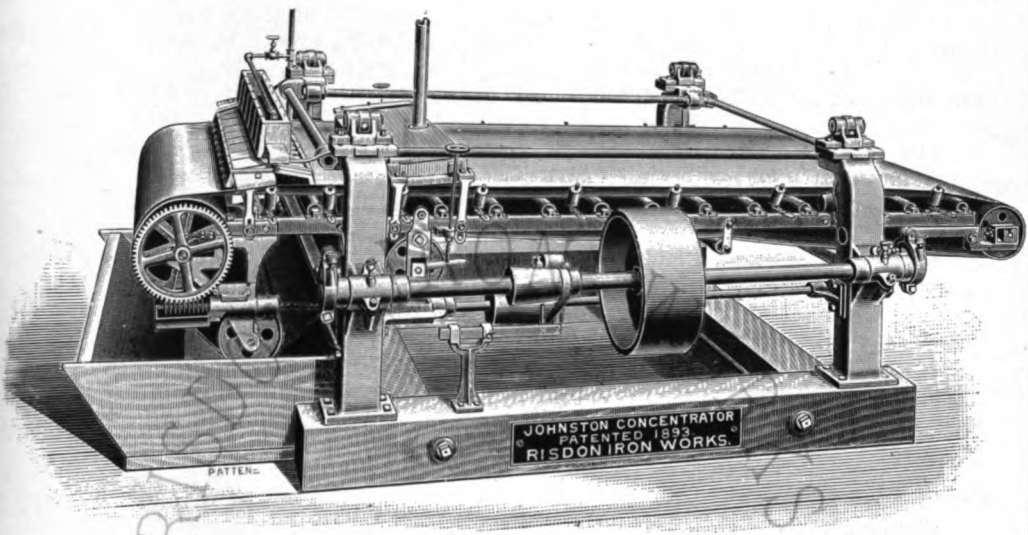
Can be dumped end or side; built to run on eighteen-inch track; twenty cubic feet broken quartz, one ton; eighteen cubic feet gravel in bank, one ton.

We manufacture special sizes and shapes of bodies as well as axles, boxes, wheels, as may be required. All our cars are very substantially made and built of best quality of material.

We also manufacture all kinds of self-dumping skips.

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... The Johnston Concentrator



THE RISDON IRON WORKS

SOLE MANUFACTURERS.

Office and Works:

Corner BEALE and HOWARD STREETS,

San Francisco, Cal.

BUILDERS OF

Improved Bryan Roller Mills,
Ore Feeders, Rock Breakers,
Mining, Milling, Pumping, and Hoisting Plants.

CATALOGUES AND PRICES FURNISHED ON APPLICATION.

Address all communications . . .

RISDON IRON WORKS.

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The Johnston Concentrator.

Among the many devices and improvements in late years in mining apparatus, considerable ingenuity has been shown in the development of a perfect concentrator. More time and thought has been given to this machine than any other connected with mining machinery. The result has been one of marked progression, and in the Johnston concentrator, which we are now building, we claim to have the most satisfactory machine yet evolved from the many types previously in use.

The following description by the inventor will explain its many points of superiority, and will readily demonstrate to the practical mining man the numerous advantages possessed by the Johnston concentrator.

The points of excellence are briefly as follows:

Simplicity of construction, great durability, ease of operation, increased capacity and percentage of sulphurets saved.

This concentrator is the invention of Geo. Johnston, who was the inventor of the first revolving belt concentrator "with raised edges and a shaking or rocking motion from side to side." Patented July 9, 1867, to Geo. Johnston and E. G. Smith. It overcomes all the difficulties and objections to the horizontal side shake machines, which pile the sand on the sides of the belt, or to the motion of the rocker, which throws the material to the center of the belt.

Our new machine has an iron frame and shaking table, and is manufactured with the greatest care.

The belt frame is suspended from four non-parallel hangers placed in a frame, and, by regulating their angle, the oscillation necessary to keep the sides of the belt from being overloaded with sands is obtained, while the oscillation is not sufficient to overload the belt in the center, as the case with the rocker. The result of this motion is a perfect concentrating surface the entire width of the belt.

Small rollers, at an angle of about sixty degrees, stand on a slotted base, screwed to the top of the belt frame keeping up the sides of the belt to prevent overflow. If the belt shifts to either side it can be followed up by these rollers, and answers all the purposes of molded edges, which are expensive and short lived.

The pulp box discharges the pulp in narrow channels ten inches apart in the direction of the belt's travel, leaving space on the belt where the sulphurets can remain undisturbed by the fall of water or sand, and pass up to the clear water at the head of the belt, the sand at the same time passing down unobstructed.

This machine requires very little attention and is easily regulated. The four and one-half-foot belt will do the work of five ordinary stamps, while the six-foot belt will work for five heavy stamps.

Price with prepared canvas belt:

4½-foot belt $400, weight boxed 2,070 lbs., foundation frame 375 lbs. additional.
6 " " 480, " " 2,280 " " " 460 " "

Price with plain friction rubber belt:

4½-foot belt $425, weight boxed 2,100 lbs., foundation frame 375 lbs. additional.
6 " " 500, " " 2,310 " " " 460 " "

Price with rubber belt, molded edges:

4-foot belt } depending on kind of belt.
6 " " }

Write for discounts.

It is not necessary that the foundation frame should be sent with the machine; it can be easily made from the blue print at the mine.

This machine is complete in itself.

No expensive frame and foundation being required in addition to what we send, a solid floor is all that is required to set it on.

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Testimonials.

Yellowstone Mining Co.

Bear Valley, Mariposa Co., Cal., April 5, 1895.

Risdon Iron Works, San Francisco, Cal.:

Gentlemen: We are well pleased with the concentrator. It saves the sulphurets clean and close; from assay of sand made they only found a trace of sulphurets.

Yours,

YELLOWSTONE MINING CO.,

C. H. BURT, Supt.

The Gold Valley Mining Co. of San Francisco.

Mission San Jose, Cal., October 17, 1895.

Risdon Iron and Locomotive Works, San Francisco, Cal.:

Gentlemen: We take pleasure in having to inform you that, after a careful investigation extending over six weeks' steady run alongside of six other concentrators, the Johnston which you put in for us was the only machine from which you could not find a loss in the tailings. It has done all you claim for it, and has proved more than satisfactory. We intend replacing all our other concentrators with Johnston's, as we are convinced they will pay for themselves many times over in a year.

CHAS. C. McIVER, President.

D. CUSHMAN, Secretary.

[On October 29, 1895, we furnished this company four more machines, replacing other machines.]

[EXTRACT.]

Gold Bluff Mine.

Downieville, Cal., January 24, 1894.

Risdon Iron Works:

"The machine has the same monotonous record, *i. e.*, they absolutely save all except traces of sulphurets."

Respectfully,

W. KRAFT, Superintendent.

[EXTRACT.]

Gold Hill, Oregon, January 24, 1894.

Risdon Iron Works:

"We take pleasure in advising you that the Johnston concentrator is still doing excellent work. Mr. J. B. Weston, late of Plymouth, says: 'The Johnston is the most perfect concentrator I ever saw. It is the Frue improved at last.'"

LUCKY BART MINING CO.,

MORTON LINDLEY, President.

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Phoenix Mine,
Butte Co., March 5, 1894.

Risdon Iron Works, San Francisco:

Gentlemen: After six months' use of the Johnston concentrator we find it a very perfect machine; much better than any heretofore used. The wearing parts and canvas belt have not given us a minute delay. The slight side tilt is perfect in equal distribution. Loss in tailings nominal and not worthy of consideration.

W. H. RODDA, Superintendent.

Percha Mine, Hillsboro, New Mexico, March 30, 1894.

"The Johnston concentrator does its work to perfection."

GEORGE S. OLIVER, Superintendent.

California Midwinter International Exposition,
Golden Gate Park, San Francisco, Cal., September 5, 1894.

DIPLOMA GOLD MEDAL AWARDED RISDON IRON WORKS ON JOHNSTON CONCENTRATOR.

Extract from report of the General Superintendent to the Executive, Finance and Advisory Committee of the California State Mining Exhibit of the California Midwinter International Exposition:

"I consider that the Committee is under special obligations to Mr. Johnston for the use of his excellent concentrator in our mill, as the same did splendid work, and greatly facilitated the milling of our ore."

EDWARD H. BENJAMIN, General Superintendent.

San Francisco, Cal., June 1, 1894.

The Risdon Iron Works, San Francisco:

"Gentlemen: We have tested the Johnston concentrator furnished us by you on trial, and, after an exhaustive test, we are satisfied it is the best in the market.

Please prepare and ship us, as soon as possible, thirteen more machines.

Yours truly,
APOLLO CONS. MINING CO.,
(Signed.) By LEON SLOSS.

Grass Valley, July 15, 1895.

Risdon Iron Works:

Gentlemen: I take pleasure in speaking to you of the Johnston concentrator. I have run the concentrators for a year and they give the best satisfaction for the thoroughness of their work. The simplicity of construction, and the ease with which they are regulated, and run with varying degrees of speed and load, place them in my estimation at the head of the belt machines.

Respectfully yours,
A. F. PERRIN,
Supt. State Ledge Mine.

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Bert Langridge, Ph. D., Mining Engineer,
Superintendent Hudson Gold Mining Co., Ward, Colorado, and
Superintendent Gold Quarry Company, Ballarat, Colorado.

Ward, Colorado, June 8, 1894.

Risdon Iron Works, San Francisco:

Gentlemen: After a thorough test of the Johnston concentrator I am so well satisfied that I wired you to ship me two more as speedily as possible.

I find the machine well constructed, easily kept in order, requiring but little attention and doing entirely satisfactory work on our ore.

After my experience with other tables I am congratulating myself on my possession of the Johnston. Yours faithfully,

(Signed) B. LANGRIDGE.

[On January 15, 1895, we shipped to Mr. Bert Langridge four more machines for his new mill, which is a further indorsement of them.]

Bullion-Beck and Champion Mining Company.

Eureka, Utah, August 24, 1895.

The Risdon Iron and Locomotive Works, San Francisco:

Gentlemen: In February last, in connection with the five-foot Bryan roller mill which we took from you to test in competition with the Huntington mill, we also took a six-foot Johnston concentrator to be tested with ten Frue's, one end shake with four belts, and one side shake Woodbury. We have been working these machines since the mill was completed at such times when we had sufficient water.

The terms on which the test was made was that the machine doing the most satisfactory work should be accepted and the others taken out. This did not apply to the Frue, as they were purchased with the plant. In compliance with this agreement, we now inform you that the Johnston concentrator has proved so superior over the other machines that we now order from you four more of the Johnston concentrators. Yours truly,

JOHN BECK, President.
SIMON BAMBERGER, Director.
W. J. BEATIE, Secretary.

[EXTRACT FROM LETTER.]

The Guggenheim Smelting Company.

Perth Amboy, N. J., September 22, 1896.

The Risdon Iron and Locomotive Works, San Francisco, California:

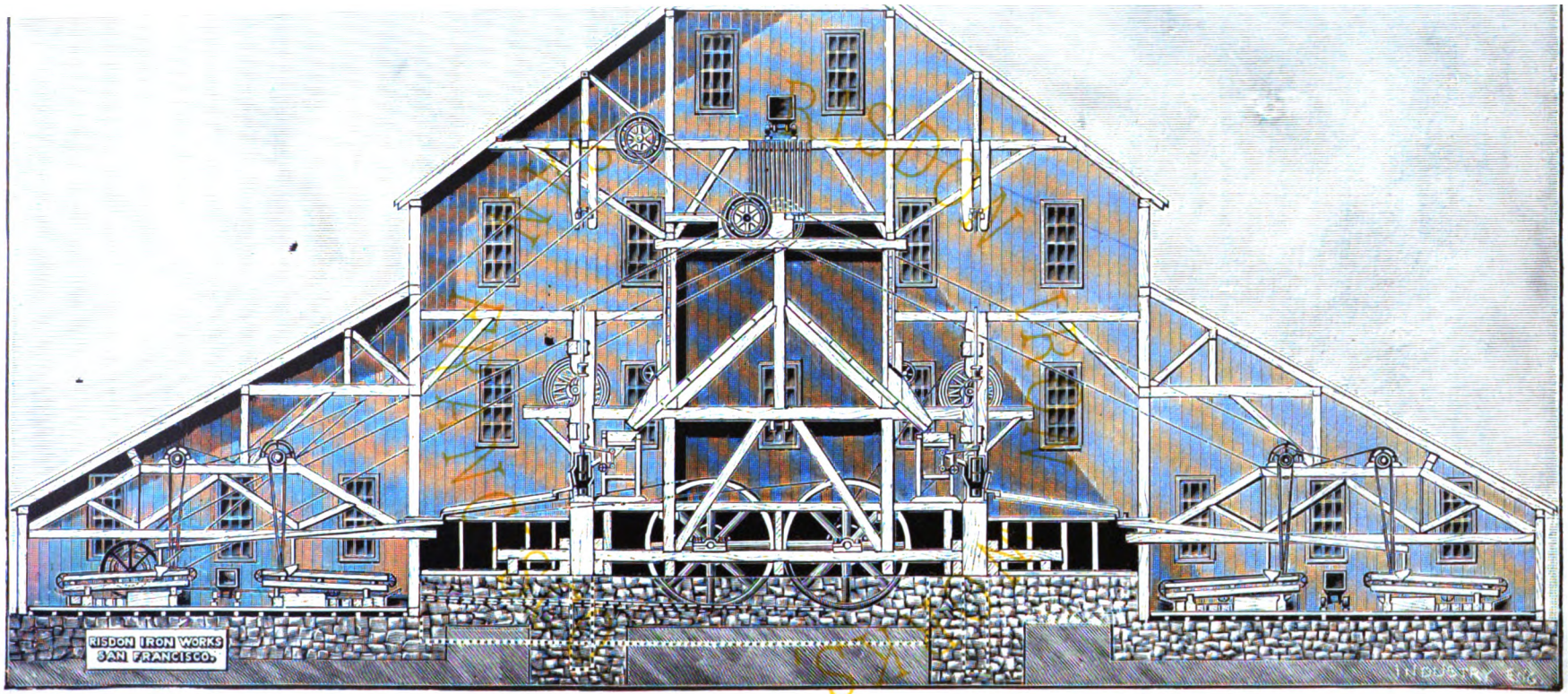
Gentlemen: "In response to your request, I am pleased to state that, from my experience in Gibbonsville, Idaho, last year, I can highly recommend the work performed by the Johnston concentrator, both as to saving of values as well as to capacity. The concentrates were clean and the tailings from $25.00 gold ore showed only traces of gold though the ore was inclined to slime." Very truly yours,

(Signed) OSCAR SZONTAGH, Superintendent.

Care Guggenheim Smelting Company, Perth Amboy.

SEND FOR CIRCULARS.

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Section of the Alaska Treadwell Co's 240 Stamp Concentrating Gold Mill.

THE LARGEST MILL IN THE WORLD. BUILT BY THE RISDON IRON WORKS.

On pages 47 and 48 we give an extract of the cost of milling at this mill.

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Alaska Treadwell Gold Mining Company.

We give a copy of this company's milling account, which we think is the best record to date, and would state that we furnish stamp mills for any capacity, which, under similar conditions, can be depended to fully equal this record.

This table is for one year.

MILLING ACCOUNT.

263,670 tons crushed. 4,373$\frac{9}{10}$ tons concentrates saved.

	Cost per ton.		
LABOR.			
Foreman and assistant	$0.0162	$4,274 12	
Carpenters	.0117	3,094 12	
Amalgamators	.0192	5,064 74	
Feeders	.0302	7,954 02	
Concentrators	.0288	7,589 30	
Oilers	.0073	1,932 62	
Crushers	.0142	3,744 89	
Ditchman	.0171	4,497 35	
Laborers	.0002	65 08	
Total milling labor	$0.1449		$38,216 24
SUPPLIES.			
Battery shoes, 572, 84,697 lbs.	$0.0240	$6,334 67	
Battery dies, 480, 67,225 lbs.	.0173	4,559 66	
Concentrator extras	.0115	3,022 13	
Screens, 1,300 square feet	.0021	548 50	
Mortars, two	.0018	470 00	
Transmission rope, 1,853 lbs.	.0009	240 16	
Lumber, 76,401 feet	.0038	1,010 82	
Coal, 167½ tons	.0045	1,186 37	
Assay office account	.0010	255 57	
Electric light account	.0034	897 31	
Car account	.0015	385 22	
Repair account	.0170	4,486 91	
Steam power account	.0748	19,725 88	
Feeder extras	.0021	558 20	
Boss heads, 12	.0009	248 75	
Quicksilver, 48 flasks	.0074	1,942 00	
Mortar liners, 58,058 lbs.	.0143	3,783 13	
Lubricants, 644 gals.	.0006	163 71	
Lubricants, 2,389 lbs.	.0009	235 35	
Cam shafts, 3	.0011	297 00	
Belting, 439½ feet	.0011	290 10	
Amount carried forward	$0.1920	$50,641 44	$38,216 24

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MILLING ACCOUNT—Cont'd.

	Cost per ton.		
Amount brought forward	$0.1920	$50,641 44	$38,216 24
Crusher extras	.0070	1,843 59	
Clean-up barrel and balls	.0005	128 96	
Rope sheaves, two, 2,887 lbs.	.0007	180 07	
Rope, 1,081 lbs.	.0005	128 48	
Mortar aprons, 3,311 lbs.	.0006	135 33	
Guide blocks, 120 pair	.0004	114 00	
Miscellaneous	.0005	142 16	
Babbitt metal, 256 lbs.		33 76	
Lace leather, 114½ feet		28 26	
Coal oil, 330 gals.		82 00	
Waste, 488 lbs.		44 68	
Mill and whisk brooms, 116		28 50	
Screws		27 78	
Pipe fittings		32 46	
Bolts, assorted		35 80	
Nails, 1,464 lbs.		68 45	
Candles, 760 lbs.	.0025	84 50	
Shovels, 14		15 05	
Concentrator extras		92 50	
Guide blocks extras		20 00	
Hose, 250 feet		62 50	
Handles, assorted, 39		7 05	
Glass and putty		9 87	
Cyanide of potassium		11 75	
Water-wheel buckets		24 50	
Zinc, 1,025 lbs.		55 05	
Shingles, 2,500		6 00	
Torches and lanterns		6 05	
Tools		13 05	
Russia iron buckets, 6	.0009	16 00	
Set screws, 12		3 00	
Tallow, 501 lbs.		26 50	
Packing, 262 lbs.		79 55	
	$0.2056	$54,228 64	
Less sales through merchandise	.0029	773 54	
Total milling supplies	$0.2027		53,455 10
Total milling labor	.1449		
Total milling costs	$0.3476		$91,671 34

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RISDON • IRON • WORKS

CABLE ADDRESS: "RISDONS."

CORNER BEALE AND HOWARD STREETS, SAN FRANCISCO, CAL.

IMPROVED

Mining, Milling, Marine and other Machinery

OF ANY REQUIRED MAGNITUDE.

A COMPLETE STOCK ON HAND OF

CORLISS, AUTOMATIC AND SLIDE-VALVE ENGINES.

Johnston Concentrators.
Hydraulic Riveted Water Pipe.
Sheet Steel and Iron Pipe.
Risdon Challenge Ore Feeders.
Hydraulic Pumping Machinery.
Ball Automatic Engines.
Bryan Roller Quartz Mills.
High Pressure Condensing Compound.
Triple and Quadruple Expansion Stationary Engines.
High Pressure, Condensing, Triple and Quadruple Expansion Marine Engines.
Improved Wheelock Engines with Hill Valve Gear.
Fisher & Hoskin's Giants and Deflectors.
McBeth Steel Pulleys.
Sullivan Diamond Drills.
Blake Damper Regulators.
Direct Acting Hoisting Engines.
Ryan-McDonald Hoisting Engines.
Geared Hoisting Engines.
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Hand Winches.
Conover Condensers.
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Rock Drills and Compressors.
Water Works for Town Supplies.
Whims and Attachments.
Back Pressure, Globe and Cylinder Relief Valves.
Ring Inlet Air Compressors.
De Rycke Steam Separators.
Plunger and Bucket Mining Pumps.
Working and Balance Pump Bobs.
Marine Boilers of every type.
All kinds of Marine Machinery.
Gas and Corliss Engines.
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Electric Light and Electric Railway Machinery.
Mill and Mining Appliances of all kinds.
Gold Stamp Mills.
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Bulkley Condensers.
Ashton Pop Valves.
Irrigating Plants.
Davidson-Van Wies Pumps.
Smith-Vaile Duplex Pumps.
Water Wheels, efficiency guaranteed.

Designs and Patterns of the Largest and most Complete Mining Machinery. Sectional Machinery to Order.

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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Evans Patent Hydraulic Gravel Elevator,

Pumping eighteen million gallons per day fifty-two feet high at
GOLDEN FEATHER CHANNEL, LD., OROVILLE, BUTTE CO., CAL.

RISDON IRON WORKS, Sole Manufacturers. Send for Catalogue.

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CATALOGUE No. 11



THE

Risdon Concentrator

"FRUE TYPE."



BUILDERS OF

Improved Bryan Roller Mills
Evans Hydraulic Elevators and
Hydraulic Mining Machinery
Risdon Water Wheels "Pelton Type"
Ore Feeders, Rock Breakers
Mining, Pumping and Hoisting Plants



PUBLISHED BY

The Risdon Iron Works

SAN FRANCISCO, CAL.

1898

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JOHN CRERAR
LIBRARY

Terms, Shipments, Etc.

TERMS

Cash on delivery at our works, or one-third cash with order, balance subject to sight draft with bill of lading.

SHIPMENTS

Give full shipping directions with order. State whether preference is to be given to a certain route, and, if so, give the name of railroad, etc.

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Risdon Iron and Locomotive Works

SAN FRANCISCO, CAL.

MANUFACTURERS OF IMPROVED

MINING MACHINERY

Adapted to Mining Operations of any Magnitude, and the Systematic Treatment of Gold, Silver, Copper, Lead and other Ores, by any of the Popular Methods

Direct Acting Hoisting Engines
Direct Acting Pumping Engines
Geared Hoisting Engines
Hydraulic Pumping Plants
Friction Hoisting Engines
Portable Hoisting Engines
Rock Drilling Machinery
Geared Pumping Engines
Water Wheel Hoists
Hydraulic Hoists
Steam Pumps
Plunger Pumps
Bucket Pumps
Working Bobs
Balance Bobs
Air Compressors
Ventilating Machinery
Tramway Machinery
Hoskins' Giants
Evans' Hyd. Gravel Elevators

Water Jacket Smelting Furnaces
Lead-Silver Smelting Works
Reverberatory Roasting Furnaces
Mechanical Roasting Furnaces
Revolving and Kiln Ore Dryers
Gold Stamp Mills
Copper Smelting Works
Feed-Water Heaters
Concentrating Mills
Silver Stamp Mills
Bryan Roller Mills
Chlorination Works
Steam Engines
Steam Boilers
Steam Feed Pumps
Water Wheels
Power Transmission
Common Sense Whims
Johnston Concentrators
Risdon Concentrators

Steam Vessels and Marine Machinery

Including High Pressure, Condensing, Compound, Tripple and Quadruple Expansion Engines; Steam Boilers of the Latest Designs, and other Machinery Equipments for Steam Vessels Designed and Built for all Kinds of Ocean, Harbor and River Service.

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For the Application of Steam Power, Hydraulics, Pneumatics, Electricity and for Manufacturing Purposes

EXCLUSIVE AGENTS AND MANUFACTURERS

For the Pacific Coast of Heine's Safety Boilers, Steel Whims, Bryan Mills, Johnston Concentrators, Hoskin's Giants, Davidson Steam Pumps, Smith-Vaile Pumps

Hydraulic Riveted Sheet Steel and Iron Pipe a Specialty

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Done in San Francisco
at PRINTING SHOP OF
THE E. D. TAYLOR CO.,
23 Stevenson St., in the
month of June and
year eighteen-hundred
and ninety-eight.

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Risdon Concentrator.

"Frue Type"

This machine is of the original Frue type — very much strengthened, simplified and improved by the use of iron and brass entirely in the shaking frame; the two inch carrying rolls are of rolled brass; the shaking frame of Channel iron; and all the gudgeons supporting the galvanized iron roll, run in loose brass boxes, which are reversible when worn, and can be easily replaced when worn out.

This machine is complete when it leaves the shop as shown in the cut. All required to set it running is the water pipe connection above the top of the post, the belt connecting with countershaft, and the pipe from the sulphuret box to the slime settler outside the mill.

General Construction of the Machine.

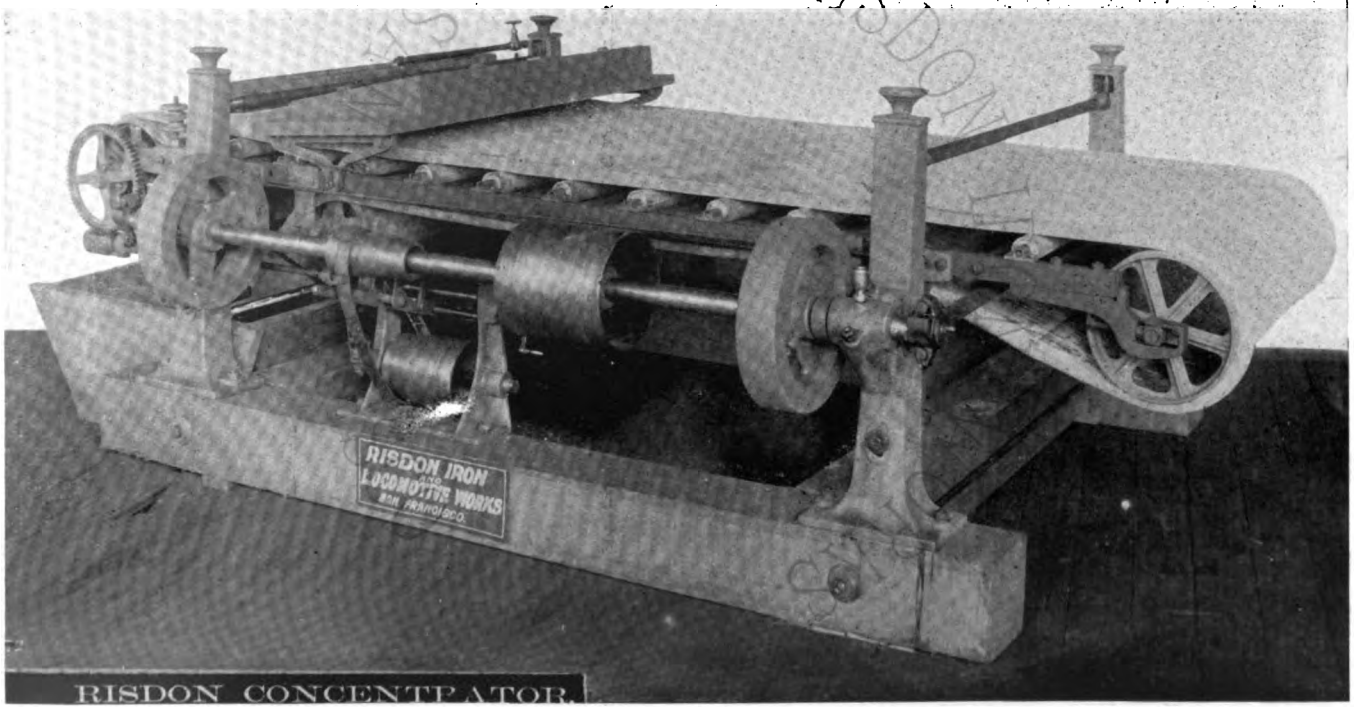
The stationary frame consists of a solid, bolted wooden base frame made of heavy timbers, on which are mounted four hollow cast-iron corner posts. These four corner posts are securely fastened and braced to the base frame and to each other. On one side of the machine these posts form the support for the journal boxes of the main driving shaft, and at the head end they support the water box.

The shaking frame is made in the most substantial manner of channel irons and rods, and is so arranged that it can be easily "squared" by lengthening or shortening the diagonal tension rods provided for that purpose. This shaking frame is supported by four supporting springs.

Directions for Setting-Up.

The foundation frame of 8 in. timbers should, when put together on the floor, be squared and bolted firmly together. The corner posts on the right hand or driving side set up. Then lay the Channel iron on the frame, put in the distance pipe and bolts; also the diagonal stay rods; measure the distance from corner to corner diagonally, and with the stay rods, draw it perfectly square. This done, tighten up all the bolts; put on the 2 inch brass rolls and the rubber belt. The posts on the left hand side can now be set up, the distance pipes put in, and all secured in place. The belt and shaking frame can be raised, and the supporting struts set under it. The guy rods attached, and the crank rods made fast to the driving shaft, and the pipes under the table. The front hangers and their two 12 inch rollers can now be bolted in place, then the 12 inch tail roll, and afterward the 8 inch and 6 inch under rolls. After the rolls are all in place, tighten up the front and adjusting screws so as to leave the box carrying the front roller about midway of its seat. This is done for the purpose of giving space for adjustment. With the roller on the tail end, you can now give the belt the necessary tension.

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Risdon Concentrator, "Frue Type," Risdon Iron Works.

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Adjusting the Belt.

The belt always runs to the short or slack side of the machine, and is caused — if the belt is the same length on both sides — by the rollers being out of parallel or by lost motion in some of the rollers, which causes concussion and carries the belt out of line. To remedy this, see first that no jar exists. If there is remove it. Then see at what corner the belt is leading off. If, for instance, it is running to the right side of the lower tail end roller, it shows that that is the slack or short side of the belt, and the roller at that corner should be set out three or four quarter turns of the set screw. This may be sufficient unless the belt has got far over to that side, when more will be necessary; and as soon as the belt has gone to the center of the table, the roller should be let back a little to keep the belt from running too much the other way.

Some people advocate the use of the under roller to guide the belt. It is true that it can be done in this way, but—by doing it, the cause of the belts running astray is not removed,—only the strain applied by the under or friction roller is greater than the divergence caused by the unparalled rollers, and the one is pulling against the other to the great injury of the belt. The belt should never be tighter than is necessary to keep it from sagging between the two inch brass rolls.

Grade or Slope of the Belt.

The proper grade for the belt is from one-fourth to five-sixteenths of an inch to the foot. This is about the range, and depends on the character of the material being worked.

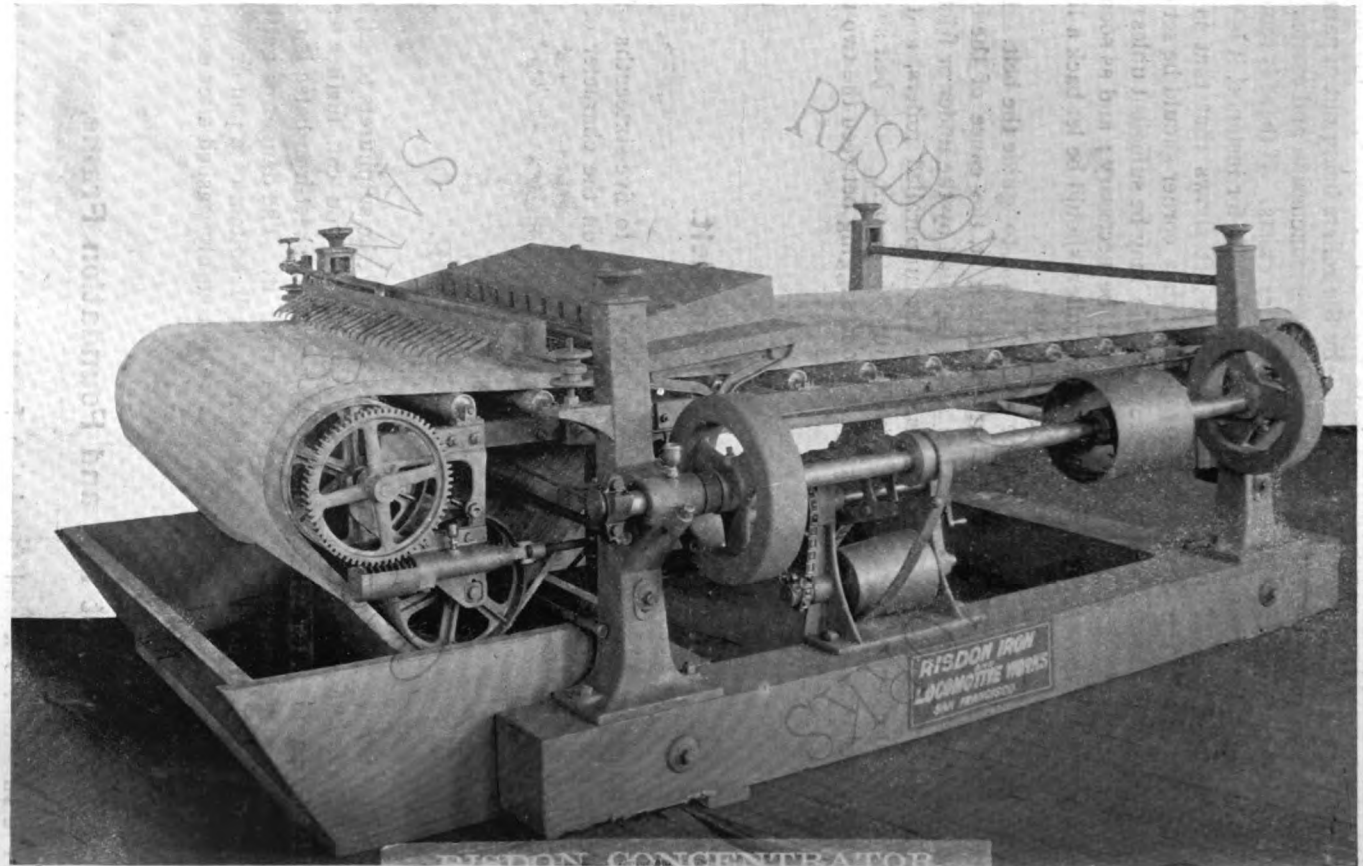
Consistency of the Pulp.

At all times the pulp must be thin, so as to allow the sulphurets to settle on the belt. In addition to judging the pulp by feeling, you can further test its condition by panning, for which purpose an enameled sheet-iron batea is recommended, as very accurate work can be done with it. The danger of getting a prospect from a previous sample owing to the rough bottom of a pan or wooden batea is avoided, as the enameled batea can be thoroughly washed after each test.

Sulphuret Box and Foundation Frame.

The sulphuret box and foundation frame can be made at the mill if it is desirable to save freight. A blue-print will be sent showing their construction and their cost at the works. $8.00 for six-foot machine and $6.00 for four-foot-six-inch machine will be deducted from the prices quoted if they are not wanted.

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Risdon Concentrator, "Frue Type," Risdon Iron Works.

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Sulphuret Box.

The sulphuret box stands directly under the front-end roller. The belt in passing round the roller No. 6, dips about half an inch into the water; this removes most of the sulphurets off the belt, but as some of the very fine sulphurets adhere to the belt, a perforated pipe directs a spray against the belt as it raises from the water and more effectually strips it of its sulphurets.

The motion of the roller and belt in the box holds some of the very fine sulphurets in suspension. These, with the overflow water, should be carried by a pipe to some convenient place, where it can be deposited in a box of sufficient size to allow all the very fine material to settle, and only the clear water allowed to run off. The amount saved is not large, but sometimes they are of value many times greater than the coarser sulphurets.

By this mode of construction, the sulphurets can, with a square pointed shovel be taken directly from the sulphuret box to the barrow or car; and the space under the shaking frame, is relieved of the settling boxes, which are always a source of trouble.

Amount of Water Required.

For a five-stamp mill one-half to one miners' inch of water is required. This is equal to five and four-tenths to ten and eight-tenths gallons per minute. If water is scarce, that leaving the concentrator can be settled and more than half of it returned for use. Close and clean concentration cannot be done without sufficient water.

For each 5 stamps, we advise the use of two of our six-foot wide machines and while some miners hold that this is too large a number of machines to mills to adopt, we contend that—where close saving is an object, the extra machines will pay for themselves in a few week' run.

Weights of the Machines.

A six-foot, moulded edge, rubber-belt machine complete, as shown in cut, weighs, when boxed, 3,000 pounds. Of this the foundation frame weighs 480 pounds, and the sulphuret box 125 pounds.

A four-foot, moulded-edge, rubber-belt concentrator when boxed ready for shipment weighs about 2,600 pounds. Of this the foundation frame weighs 400 pounds and the sulphuret box 100 pounds.

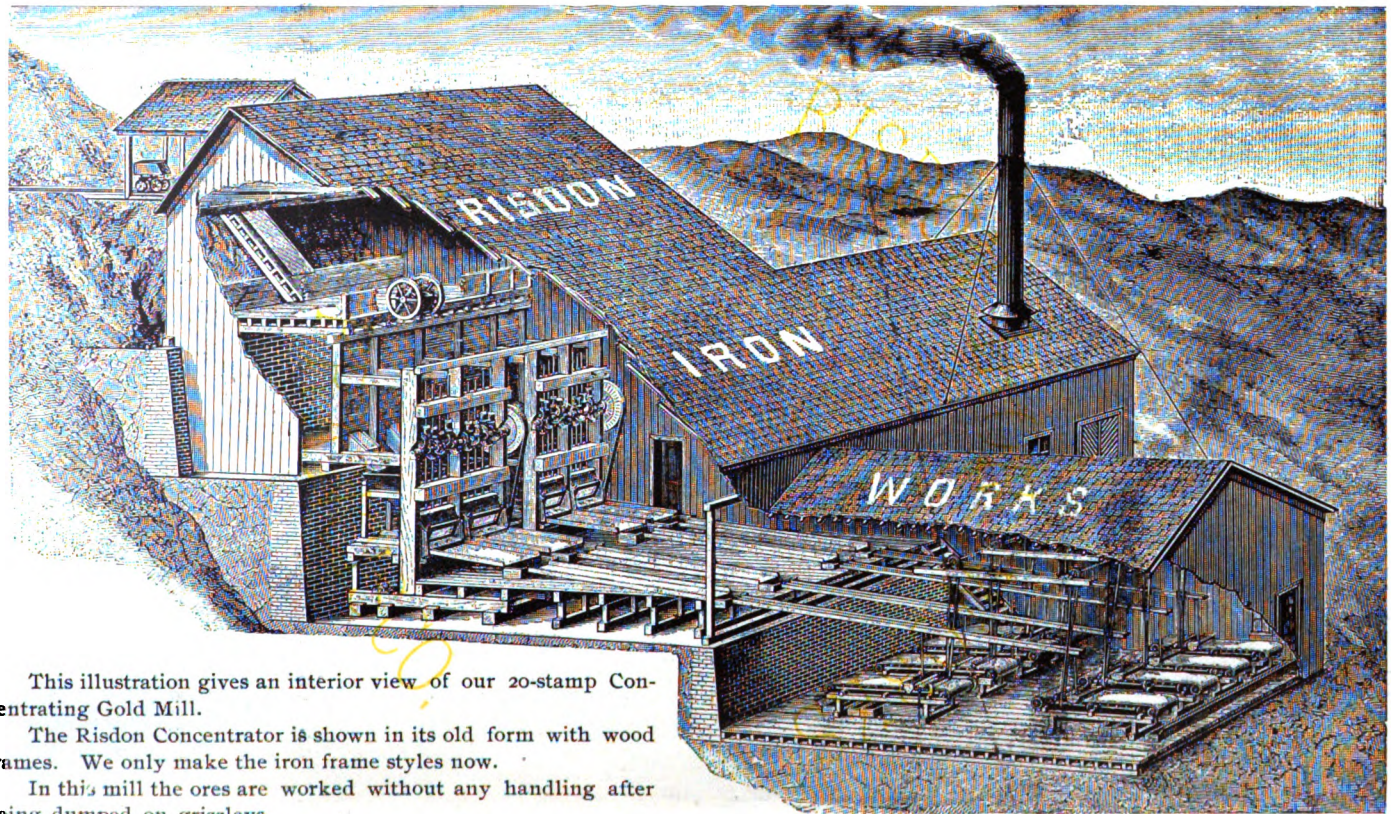
Capacity.

A six-foot belt is sufficient to handle the pulp from five stamps crushing ten tons per day of 24 hours.

A four-foot machine will handle eight tons per 24 hours.

Where the stamps are not heavy, one six-foot machine will treat all the ore crushed with a five-stamp battery and do good work.

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This illustration gives an interior view of our 20-stamp Concentrating Gold Mill.

The Risdon Concentrator is shown in its old form with wood frames. We only make the iron frame styles now.

In this mill the ores are worked without any handling after being dumped on grizzleys.

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Oil.

Keep enough oil in box No. 18 for the screw gear to dip in slightly. Keep all the journals clean, oiled and free from jar. Do not allow any roller to stop revolving and see that the edge of the belt does not rub on any part of the machine.

Floor Space Required.

Six-foot belt machine covers a floor space of eight feet three inches by eleven feet, and for convenient working requires a space of eveven to twelve feet by sixteen feet. Four-foot belt machine covers a floor space of six feet, nine inches by eleven feet, and for convenient working requires a floor space of nine feet six inches to ten feet by sixteen feet.

The height from the bottom of foundation frame to top of pulp box is 3 ft. 5 in.

The floor of the concentrator room should be seven feet below the lip of the mortar for a single row of machines; but if the mill is already built; a single row can be put in with a fall of foor and one-half feet from the box below copper plates to the concentrator floor, by carying the pulp to pulp distributor in a two-inch iron pipe.

If two rows of concentrators are used; there should be nine feet fall from from lip of mortars for convenient working, and allowing sufficient for conveniently passing under the pipes or launders.

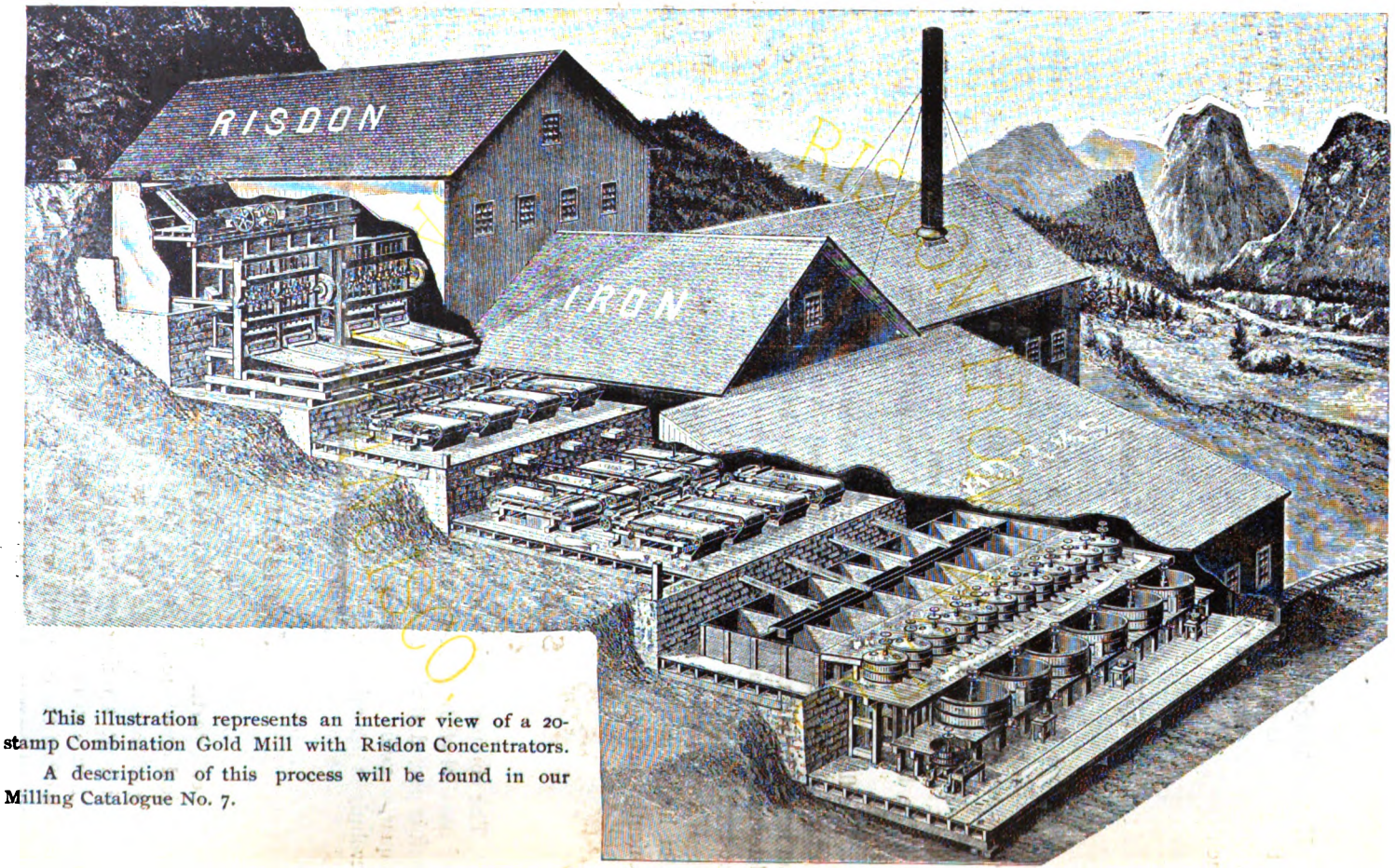
Setting the Counter Shaft.

The counter shaft to drive the Risdon Concentrators is usually placed in a line parallel with the main shaft of the mill. By this arrangement the counter shaft is placed at right angles to the crank shaft of the concentrator, and renders a quarter-twist belt necessary. See Fig. 9. Speed of either machine, 180 revolutions per minute.

Johnston Concentrator Belt.

We call particular attention to the moulded edge on the Johnston belt. The mechanical construction is such as to resist the greatest amount of strain without cracking or tearing. The edge is evenly balanced and will pass round a six inch roller without kinking or twisting the body of the belt. In its construction, sufficient pure rubber is used to prevent its being pressed out of shape in packing as is often the case with belts of light edges. It is not from its thickness so likely to get over-vulcanized as light edged belts, nor will it so readily be injured by hot climates and exposure for the same reason.

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This illustration represents an interior view of a 20-stamp Combination Gold Mill with Risdon Concentrators.

A description of this process will be found in our Milling Catalogue No. 7.

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Johnston Concentrator Belt.

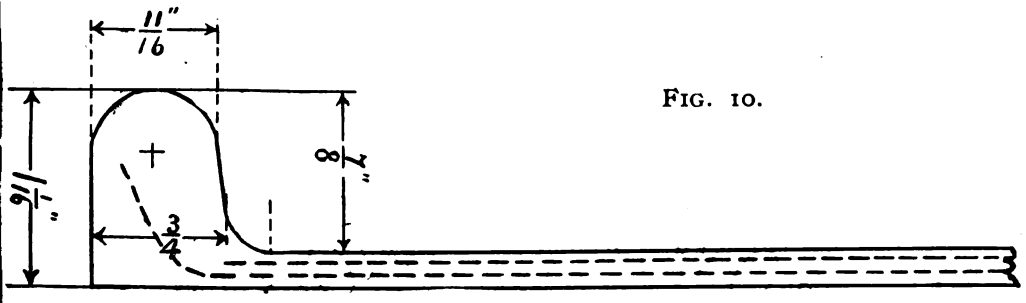


FIG. 10.

Full size cut of Johnston moulded edge on rubber belt, used on Risdon Concentrator.

Price.

The price of our four-foot wide machine is $400 at our works in San Francisco.

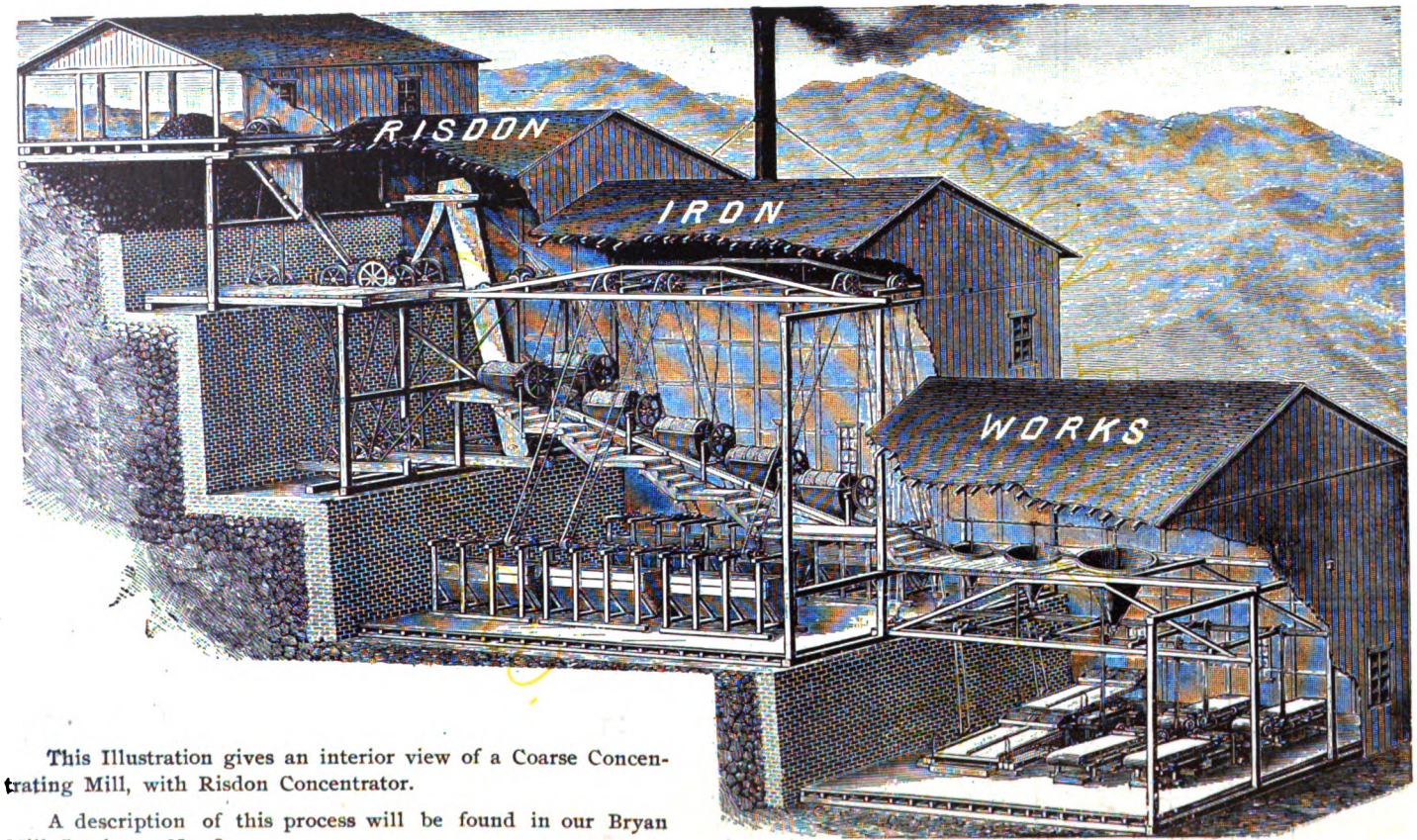
The price of our six-foot wide machine is $450 at our works in San Francisco.

To Estimate the Percentage of Sulphurets in Quartz.

Take ten thousand grains or 20.8 ounces of crushed ore which will pass through a forty-mesh wire screen. Wash the ore very carefully in batea or pan, and rewash as long as sulphurets appear. Dry and weigh. Each grain of sulphurets will equal one-hundreth of one per cent. If the sulphurets weigh 175 grains, the quartz contains one and three-fourths per cent of sulphurets, or, if twenty grains, one-fifth of one per cent. If the sulphurets are worth $100 per ton, the value of sulphurets in each ton of ore is $1.75, or, if one-fifth of one per cent, 20 cents per ton.

To test tailings, dry and weigh ten thousand grains. Wash as above. Dry and weigh the sulphurets. Each grain will represent one-hundreth of one per cent, and a loss of 1 cent per ton if the sulphurets are worth $100 per ton. Thus if the ten thousand grains of tailings yield three and one-half grains of sulphurets, the loss is 3½ cents per ton in sulphurets. If the sulphurets are worth $60 per ton, multiply sixty by three and one-half, and 2.1 cents is the value of the sulphurets in one ton of tailings. If they are worth $375 per ton, multiply as above and the value in each ton of tailings is 13.12 cents per ton in sulphurets.

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This Illustration gives an interior view of a Coarse Concentrating Mill, with Risdon Concentrator.

A description of this process will be found in our Bryan **Mill Catalogue No. 8.**

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The illustration herewith shows the position of the pulleys and shafts.

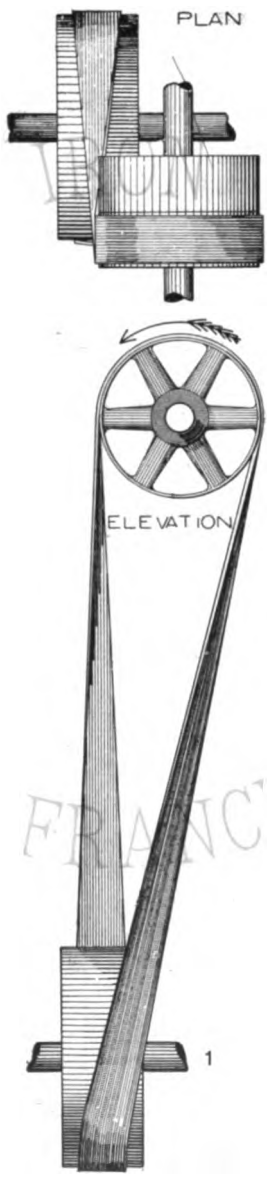


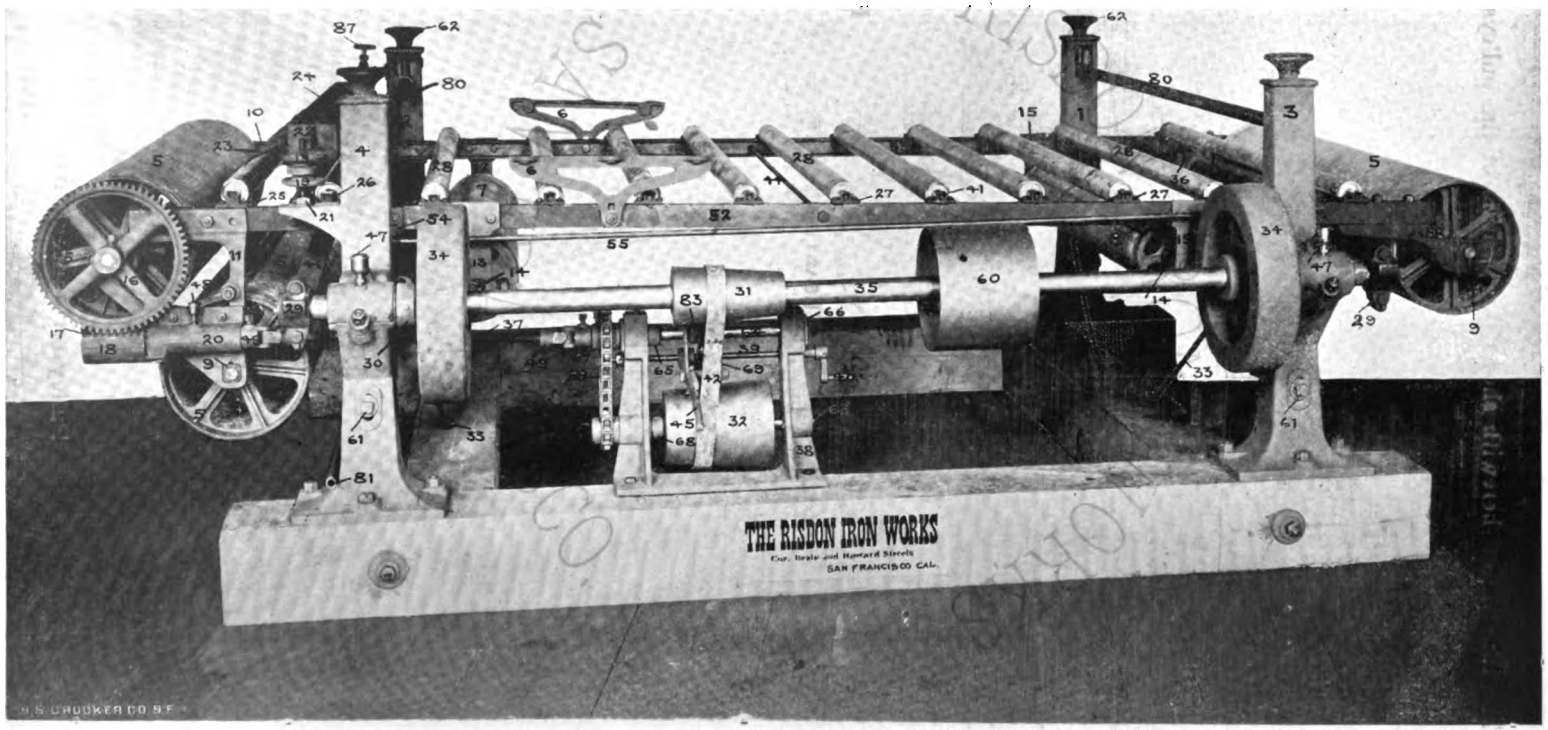
FIG. 9.

3 in
[8 in.]

Pulley on Concentrator,

To make 180 revolutions per minute. Diameter of Pulley 10 in.

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Risdon Concentrator, "Frue Type"--Numbers of Parts.

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Risdon Concentrator--Number of Parts.

1—1 corner Foot Post, left.
2—1 " Head " left.
3—1 " Foot " right.
4—1 " Head " right.
5—3 12 in. drums.
6—2 Brackets for pulp discharge box.
7—1 8 in. Drum.
8—1 6 in. Drum.
9—6 Brass Bearings for 12 in. rolls.
10—1 Bracket left side.
11—1 " for gear, etc.
12—1 " left side for 8 in. rolls.
13—1 " right side for 8 in. rolls.
14—4 Brass Bearings with set screws.
15—2 Brackets for 6 in. rolls.
16—Gear Wheel.
17—Worm.
18—Grease Cup.
19—4 Hand Wheels for water box.
20—Bearing for worm.
21 —2 Bolts for hand wheel on water box.
22—1 C. I. Water Box.
23—26 Discharge Spouts for water box.
24—Inside partition of Water box.
25—Saddles carrying rolls next to head of machine.
26—Saddles carrying second roll from head of machine.
27—Saddles carrying rolls 3-4-5-6-7-8-9-10-11 12.
28—12 2 in. Carrying Rolls.
29—2 Eccentrics.
30—2 Collars on eccentric shaft.
31—1 Small Cone Pulley.
32—1 Large Cone Pulley.
33—4 Guy Rods from post to frame
34—2 Balance Wheels.
35—1 Eccentric Shaft.
36—2 C. I. Pitman Clamps.
37—1 Rod for toggles.
38—Tightener Bracket.
39—1 Hand Screw for adjusting belt.
40—I Handle for adjusting screw.
41—24 Russia Iron Caps for saddles.
42—Leather Belt on tightener.
43—4 Lock Nuts.
44—1 central distance G. P. and bolt.
45—1 Tightener Lever.
46—2 Pieces spring steel for Pitman head.
47—2 Large Oil Cups.
48—1 Small Oil Cup.
49—Toggle.
50—4 Pieces spring steel for rocker.
51—1 Rubber Belt.
52—1 Piece Channel Iron for frame, right side.
53—1 Piece Channel Iron for frame, left side.
54—4 Brackets on channel iron for rocker.
55—2 ⅜ in. Tie Rods.
56—1 Adjusting Screw on Bracket A 58.
57—1 Large Sprocket Wheel.
58—1 Small Sprocket Wheel.
A. 58—2 Brackets for supporting 12 in. roll.
59—No. 32 Link Chain.
60—1 10 in. Pulley.
61—4 Brackets on corner post for rocker.
62—4 Cups on top of corner post.
63—1 Small Sprocket Wheel Shaft.
64—1 Large Sprocket Wheel Shaft
65—1 Set Collar on large sprocket wheel shaft.
66—2 Bearings for large sprocket wheel shaft.
67—1 Pulp Box.
68—1 Collar on small sprocket wheel shaft.
69—1 Pawl for tightener.
70—1 Sulphuret Tank.
71—Hose.
72—Screw Driver.
73—Double End Wrench.
74—Double End Wrench.
75—Single End Wrench.
76—Socket Wrench.

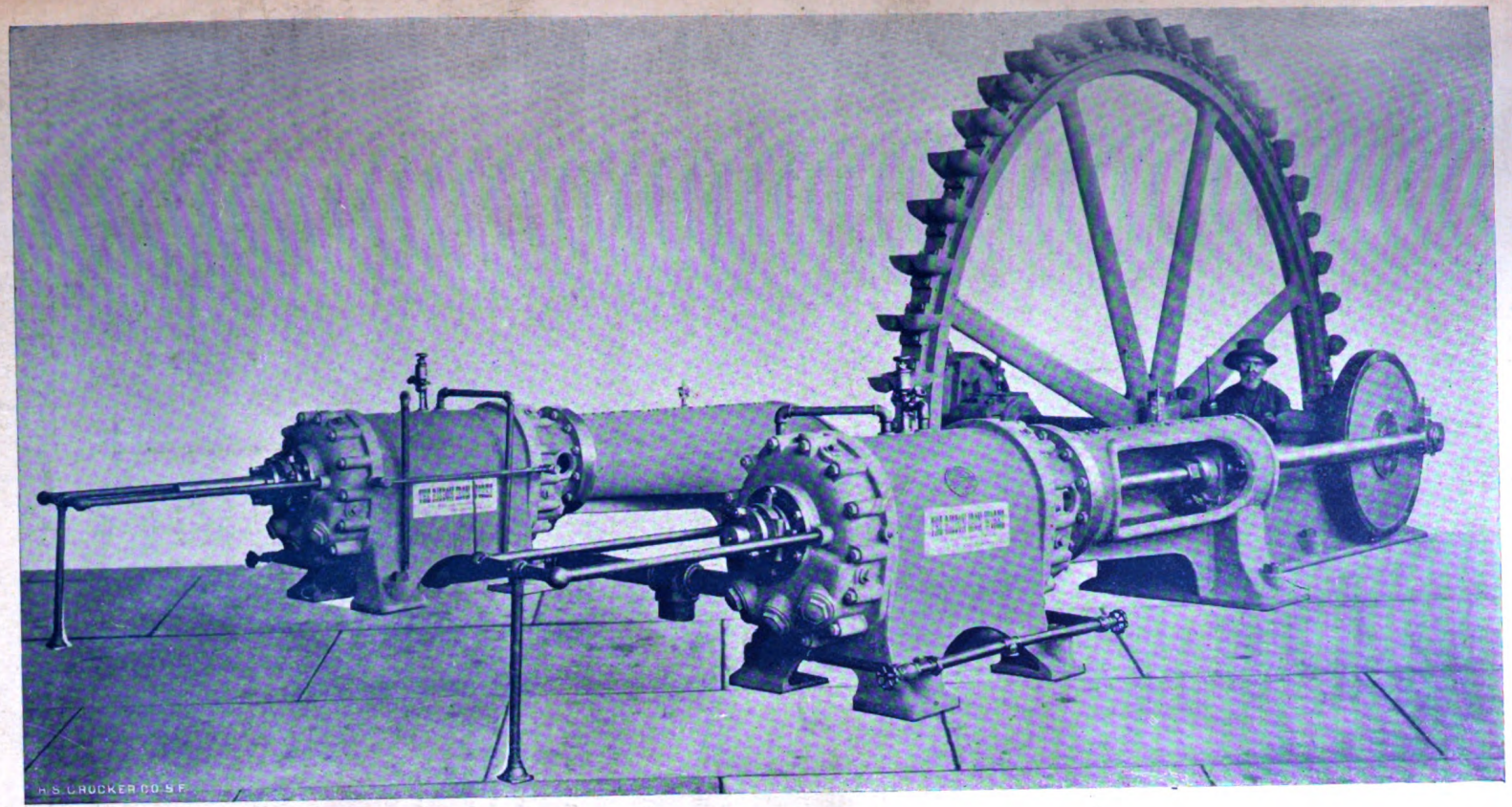
Pipes and Pipe Fittings.

77—3½ in. Elbows.
78—Pipe to which Pitman clamps are attached.
79—½ Pipe to water box.
80—2 stay Pipes.
81—1 Perforated Spray Pipe.

Extras.

82—1 piece ½ in. x 15 in. G. P.
83—1 piece ½ in. x 7 in. G. P.
84—1 piece ½ in. x 5 in. G. P.
85—2 pieces ½ in. x 1½ in. G. P.
86—1 Red. Tie ½ in. x ½ in. x ¼ in.
87—3 ½ in. Valves.

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500 Horse Power Risdon Inlet Air Compressor, driven direct by Risdon Water Wheel, 24 feet diameter.

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Catalogue No. 12.

Milling Machinery

BUILDERS OF

Improved Bryan Roller Mills, Evans Hydraulic Elevators and Water Wheels, Ore Feeders, Hydraulic Mining Machinery, Rock Breakers, Mining, Pumping and Hoisting Plants.



PUBLISHED BY

THE RISDON IRON WORKS

SAN FRANCISCO

CALIFORNIA.

1897.

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Terms, Shipments, etc.

TERMS.

Unless otherwise specified and previously agreed to, and to those customers who have not established credit relations with us, our terms are always one-third cash with the order and the balance when goods are ready to ship.

SHIPMENTS.

Give full shipping directions with order. State whether preference is to be given to a certain route, and, if so, give the name of railroad, etc.

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RISDON IRON AND LOCOMOTIVE WORKS

SAN FRANCISCO, CAL.

Manufacturers of IMPROVED

MINING MACHINERY

Adapted to Mining Operations of any Magnitude, and the Systematic Treatment of Gold, Silver, Copper Lead and other ores, by any of the Popular Methods

Direct Acting Hoisting Engines
Direct Acting Pumping Engines
Geared Hoisting Engines
Hydraulic Pumping Plants
Friction Hoisting Engines
Portable Hoisting Engines
Rock-Drilling Machinery
Geared Pumping Engines
Water Wheel Hoists
Hydraulic Hoists
Steam Pumps
Plunger Pumps
Bucket Pumps
Working Bobs
Balance Bobs
Air Compressors
Ventilating Machinery
Tramway Machinery
Hoskin's Giants
Evans Hyd. Gravel Elevators

Water Jacket Smelting Furnaces
Lead-Silver Smelting Works
Reverberatory Roasting Furnaces
Mechanical Roasting Furnaces
Revolving and Kiln Ore Dryers
Gold Stamp Mills
Copper Smelting Works
Feed-water Heaters
Concentrating Mills
Silver Stamp Mills
Bryan Roller Mills
Chlorination Works
Steam Engines
Steam Boilers
Steam Feed Pumps
Water Wheels
Power Transmission
Common Sense Whims
Johnston Concentrators
Risdon Concentrators

Steam Vessels and Marine Machinery

Including High Pressure, Condensing, Compound, Triple and Quadruple Expansion Engines; Steam Boilers of the Latest Designs, and other Machinery Equipments for Steam Vessels Designed and Built for all Kinds of Ocean, Harbor, and River Service

GENERAL MACHINERY

For the Application of Steam Power, Hydraulics, Pneumatics, Electricity and for Manufacturing Purposes

EXCLUSIVE AGENTS

For the Pacific Coast of Heine's Safety Boilers, Steel Whims, Bryan Mills Johnston Concentrators, Hoskin's Giants, Davidson Steam Pumps, Smith Vaile Pumps

HYDRAULIC RIVETED SHEET STEEL AND IRON PIPE A SPECIALTY

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AS A PREFACE

ON account of the great diversity of our business, we have been compelled to issue this Catalogue, especially devoted to the Milling of Gold and Silver ores. In no other way could justice be done to this very important and extensive industry.

We have enjoyed for many years a very large share of the mining patronage of the Pacific Coast, and the largest Mills that have been erected for the treatment of the precious metals, are evidence of our great facilities for the construction of these plants.

In the preparation of this book, we have given place to only the most advanced types and approved designs of Gold and Silver Milling Machinery.

Guided by the experiences of expert Mill builders and Mill operators, we have selected the plans and methods that have been endorsed by the most intelligent authorities on this subject.

We have aimed to make it valuable to Mill and Mining Men and Engineers, as a source of ready reference, so that it may be preserved as a useful aid in making estimates and calculations at some future time.

We are prepared to undertake the furnishing and erecting of machinery to suit any plans that may be furnished or required, whether referred to in this Catalogue or not.

The various general and detail specifications given herein are subject to changes to suit special requirements. We have not given general prices, as we prefer to quote net prices on application.

We have designs and patterns for every variety of Mill and Mining Machinery, and furnish estimates on short notice.

The Risdon Iron Works occupy a most central location within a few blocks of the actual center of the city and in the immediate vicinity of ferries and principal wharves. They have been established over a quarter of a century and have a working capacity of 1500 men.

Any further information required not contained in this Catalogue we will at all times cheerfully give, and invite correspondence in relation thereto.

The Risdon Iron Works.

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MILLING MACHINERY

THE selection of the most profitable process, and the best adapted machinery for the treatment of a given ore, is a matter of great importance in a mining enterprise; but as some ores are susceptible of successful working by more than one process—and in such cases local conditions must determine which method will yield the greatest profit—it is not possible to lay down exact rules covering all cases. The following notes will, however, serve as a guide in some instances, and in all as a general indication of the principles of the processes in common use, and conditions governing their application.

FREE-GOLD MILLING

Is applied to ores in which the gold is either partly or wholly free, that is, native or metallic. The treatment of these ores is very simple. They are crushed under stamps, wet, and the pulp flows over copper plates, whose surfaces are amalgamated with quicksilver. The gold attaches itself to the silvered surfaces of the copper in the form of amalgam, a combination of gold and quicksilver, and is collected at intervals, and retorted to separate the quicksilver from the gold, the residue, which is called crude bullion, is then melted into bars. This process, in a well-arranged mill, is the cheapest in use for gold extraction, so that low grades of ore can be worked to a profit; as ores yielding not over $3.00 per ton have been worked at a profit, the milling often costing less than 50 cents per ton of ore.

CONCENTRATING GOLD ORES

When gold-bearing ores contain other minerals, principally the sulphurets of iron and copper, more rarely lead and zinc, occasionally various tellurides, selenides and antimonides of the above metals, with, in nearly all cases, a varying small amount of silver. Whenever these minerals (in a general way called sulphurets) are of such value that they can be profitably worked after concentration, concentrators or vanners are employed to separate those sulphurets from the pulp after passing over the amalgamating plates. In this operation 100 parts of pulp may be reduced to one or more parts of concentrates.

The subsequent treatment of the sulphurets depends on their value and local circumstances. Some of the larger mining companies build chlorination works to treat their own sulphurets, while many smaller mines ship their concentrates to the nearest reduction works.

The quantity of silver in gold ores may affect their treatment when it exceeds a certain limit. In small quantities, as is usually the case with what are termed free-milling gold ores, the silver is saved, with the gold that escapes the amalgamating plates, in the concentrations, and can be extracted equally well by smelting or pan amalgamation, or by some modifications and addition to the chlorination process. When the value of silver is high, the ore would be classed among silver milling, and be treated under one of the classes to be mentioned.

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FREE SILVER MILLING

Two classes of ore are included under this head.

First—Free milling, or ores that admit of direct amalgamation.

Second—Roasting milling, covering ores which require a preliminary roasting.

Free Milling—The ores of silver which can be successfully subjected to this process are such as contain the metals in forms which will be acted on by quicksilver, assisted by agitation, heat and certain chemicals. The operation is usually performed in amalgamating pans, each charge being worked several hours, the reactions often being very slow. The silver ores best suited to free milling are those containing native silver, chloride of silver (hornsiiver), and certain forms of sulphide of silver. The presence of much base minerals, as sulphates of iron, copper, lead, zinc, antimony, interferes with the success of the process in two ways: Directly, as fouling the amalgam and checking the reactions of the chemicals and free-milling minerals; and, indirectly, by carrying off in their own refractory combinations such silver as they contain, so increasing loss. There is no sharp line of demarkation between free and roasting-milling ores. It often happens that the upper part of silver veins are free milling, owing to decomposing action of air and surface water, while as depth is attained, sulphurets and base metals come in, till at length it becomes necessary to roast all the ore before milling, so doing for the lower part of the vein the preparatory work which Nature performed for the surface portion.

The best results on free milling are on decomposed ores—ores which have been changed in their nature through destruction of their baser elements. Occasional natural deposits of chloride of silver, and some rare occurrences of native silver unaccompanied by sulphurets, make up, with the decomposed ores, all really adapted to free milling. The process being cheaper than roasting milling, ores are sometimes worked by it which should properly be roasted, but in such cases the percentage saved is low. The cost varies very greatly with mill and conditions; the cost of fuel, labor and transportation of supplies make the cost of milling by this method to vary from $2.50 to $10.00 per ton. With intelligent and skillful management this process saves from 75 to 90 per cent. of the metal contained in the ore.

ROASTING MILLING

This class of ores can be made very large, including, under certain conditions, both smelting and concentrating ores. Ores carrying a large percentage of base metals can be worked by it; but in many cases when smelting is available from the nature of surrounding ores, the concentration of the mineral and subsequent smelting is more profitable. The process consists of roasting the ore with salt preparatory to amalgamation in pans.

The roasting may be done in reverbatory furnaces, where the ore is stirred by hand, or in mechanical revolving furnaces, such as the Bruckner, the White and the Thompson, the horizontal O'Hara furnace, or the vertical Stetefeldt furnace. This process involves the necessity of crushing dry, and a more expensive plant of machinery. The cost of this process varies from $10 to $20 per ton, and the ore is made to yield from 85 to 95 per cent. of its assay value.

LEACHING—LIXIVIATION

This process on silver ores consists of various methods of dissolving out chloride or sulphate of silver, previously formed by roasting in certain solvents, and then precipitating the silver, instead of amalgamating with quicksilver. The silver has to be in exactly the right condition, and the process requires considerable skill. The plant is less expensive than for regular milling, and under some conditions may be substituted, but it is in little use; its cost and saving are about as in roasting milling.

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CONCENTRATION

Is a preliminary process, and does not yield the metals in marketable form; it simply separates the worthless from the metal-bearing particles; the latter having a greater specific gravity are easily settled to the bottom, while the light are washed off with water. This is sometimes termed fine concentration, and various kinds of concentrators are used, such as Frue Concentrators. Triumph Concentrators and the Woodbury Concentrators.

Coarse concentration is only applicable to heavy mineral ores, as lead, zinc, iron and copper, the ores in which a comparatively coarse crushing is sufficient to admit of the required concentration. For this process the ore is run through crushing rollers instead of stamps, and from there through a series of revolving sized screens, graduated in mesh so that the particles, both of mineral and gangue, are separated into groups of various sizes, each separate size being treated on a distinct "jig," which effects the separation of gangue from mineral. The finer product, called slimes, is treated on tables of various kinds, and on vanners. The same operation can be carried out dry when water is not available.

Low-grade ores of both gold and silver are often made profitable by the fine-concentrating process. The ores on which this process can be used are numerous, encroaching on the free-milling and roasting-milling groups, argentiferous galena, zinc-blende, brittle silver, ruby silver, tellurides of gold and silver, gray copper, iron and copper pyrites, carbonate and chloride ores, often rich in mineral so finely distributed throughout the rock that its specific gravity does not always insure successful concentration.

SMELTING

Smelting can only properly be carried out on special ores of lead and copper, like the carbonates, which reduce readily, or by a careful regulation of charges carrying lead or copper in other forms, and proper intermixture of fluxes. There are in some localities ores of both copper and lead which run down in furnaces with little addition except the necessary fuel; but sulphureted ores (copper pyrites and glance and galena) cannot be so easily disposed of.

Omitting the complicated methods used in large reduction works, the following are the methods used in mining camps:

First—The simple melting, in stack or water-jacket furnaces, of carbonates of lead or copper, or metallic copper ores. Some flux is usually required for the gangue rock, iron or lime if quartz, or quartz if too limy.

Second—Matting or running the minerals out of the rock, not in a fully metallic condition, but as a concentrated mineral or matte. This operation is conducted also in a stack or water jacket furnace, usually after a partial preliminary roast. The matte is afterward refined.

Third—Partially roasting galena ores, oxidizing the lead and driving off much of the sulphur then a reducing smelting, in which the oxidized lead reacts on any sulphides remaining, and only metallic lead results. Here, as in the first division, proper fluxes must be added to slag off the waste rock and retain all the fluid in the furnace.

Fourth—The addition of iron ore, or roasted iron pyrites, to galena ores in smelting; the iron capturing the sulphur of the galena and leaving metallic lead.

A general description of the principles involved in the ordinary processes of smelting is all that is intended here, but the success of the last three methods depends on a proper mixture of ores, proper roasting and adjustment of fluxes.

The cost of smelting ores varies from $6 to $25 per ton, and the yield of the ores thus treated is from 90 to 98 per cent of their assay value.

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TO ASCERTAIN THE PROPER PROCESS

No general rule can be given for determining the most profitable process for a given ore, since the main question is, how can the greatest yield be obtained by the least cost. However, for purposes of general deduction, we will take it for granted that all the above described processes are available, therefore, to decide which process should be selected for a particular ore, we give the following brief notes:

First—If free gold can be found in panning, and no sulphurets, the process is free-gold milling.

Second—When both free gold and sulphurets are found, and the sulphurets assay high enough to pay process, free-gold milling, then concentration and chlorination or smelting for product.

Third—When free gold is found in small quantities, with much silver in the sulphurets, the process is roasting milling or free-gold milling, concentrating, and treating concentrates as before.

Fourth—For chloride of silver ores and decomposed silver vein outcrops the process is free-silver milling.

Fifth—For silver ores consisting of part chloride or decomposed, and part silver-bearing sulphurets, the process is free-silver milling, concentrating; concentrates, roasting milling or smelting.

Sixth—Silver ores carrying base metal sulphurets, if low grade, fine concentration and smelting; if high grade, roasting milling.

Seventh—Low-grade silver ores, with gray copper, ruby, brittle or native silver, fine concentration and smelting.

Eighth—Heavy mineraled ores of lead, copper and zinc, often carrying silver, concentration and smelting.

Ninth—Lightly mineralized ores of lead, copper and zinc, concentration and smelting.

Tenth—Carbonate or oxide of lead or copper, smelting.

Eleventh—Solid galena ores, smelting selected portion; concentration and smelting for rejected ore.

Twelfth—Metallic copper ores, stamping, with concentration and melting to ingot.

Thirteenth—Antimony ores, concentration and smelting.

Fourteenth—Zinc-blende and zinc carbonates, concentration and reduction by a zinc-melting process.

Fifteenth—Tin ores, concentration, roasting and smelting.

Sixteenth—Copper pyrites and copper glance, concentration, partial roasting and matting; or, if low grade, sometimes lixiviation for copper and silver.

Seventeenth—Heavy iron pyrites carrying gold, chlorination process, or roasting and intermixture with smelting ores.

Eighteenth—To determine whether a given low-grade gold or silver ore can be profitably concentrated, take a weighed quantity of dry pulverized ore passed through a 40-mesh screen, such as will be an average sample of the bulk of ore treated, say one pound, after having previously assayed the sample. Pan this quantity carefully into a second pan, and re-pan until all the sulphurets are separated from the gangue, then dry and weigh the sulphurets and assay them; the weight represents the percentage of sulphurets the ore contains.

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A MODERN GOLD MILL

As shown in Plate 5, is so arranged that the ore enters the mill at a point so much higher than the concentrating floor as to admit of its continual descent by gravity from each operation to the succeeding one, until it has passed through the mill and into the tailing reservoir below, without the expenditure of any labor or power to move it other than the specific gravity of the ore and water.

To follow the ore. On reaching the mill in wagon or mining car, it is unloaded on an inclined screen called a Grizzly, through which all particles of ore small enough to be fed to the battery pass into the ore bin, the coarser parts being diverted by the Grizzly into and through the rock breaker, and thence into the same ore bin.

The ore bin has an inclined bottom and adjustable discharging gates, through which the ore passes into the hoppers of the ore feeders, which are automatic in their operation, the feed being regulated by the supply of ore under the stamp.

One or more amalgamated or electroplated copper plates of various shapes and sizes are secured inside of each mortar. Copper plates of a similar character are placed on the aprons, which convey the pulp from the batteries. These plates amalgamate the free gold contained in the ores, the proportions saved being usually about 75 per cent on the inside and 25 per cent on the outside plates. The gold amalgam thus accumulated is collected occasionally and retorted, the quicksilver vaporizing and condensing in water, the residue in the retort being crude bullion, which is afterwards melted and cast into bars.

The majority of gold ores yield only a portion of their value to the simple milling process, the remainder being in combination with sulphur and baser metals. These sulphurets have a greater specific gravity than the gangue surrounding them, and the entire pulp is often run over concentrators or vanners of various kinds, thus concentrating the value of 100 tons of tailings into one or more tons of concentrates. The concentrates are subsequently treated by more expensive methods, as their increased value per ton will now permit of their transportation to reduction works.

Many of the largest and most complete gold mills now in successful operation have been built by the

RISDON IRON WORKS

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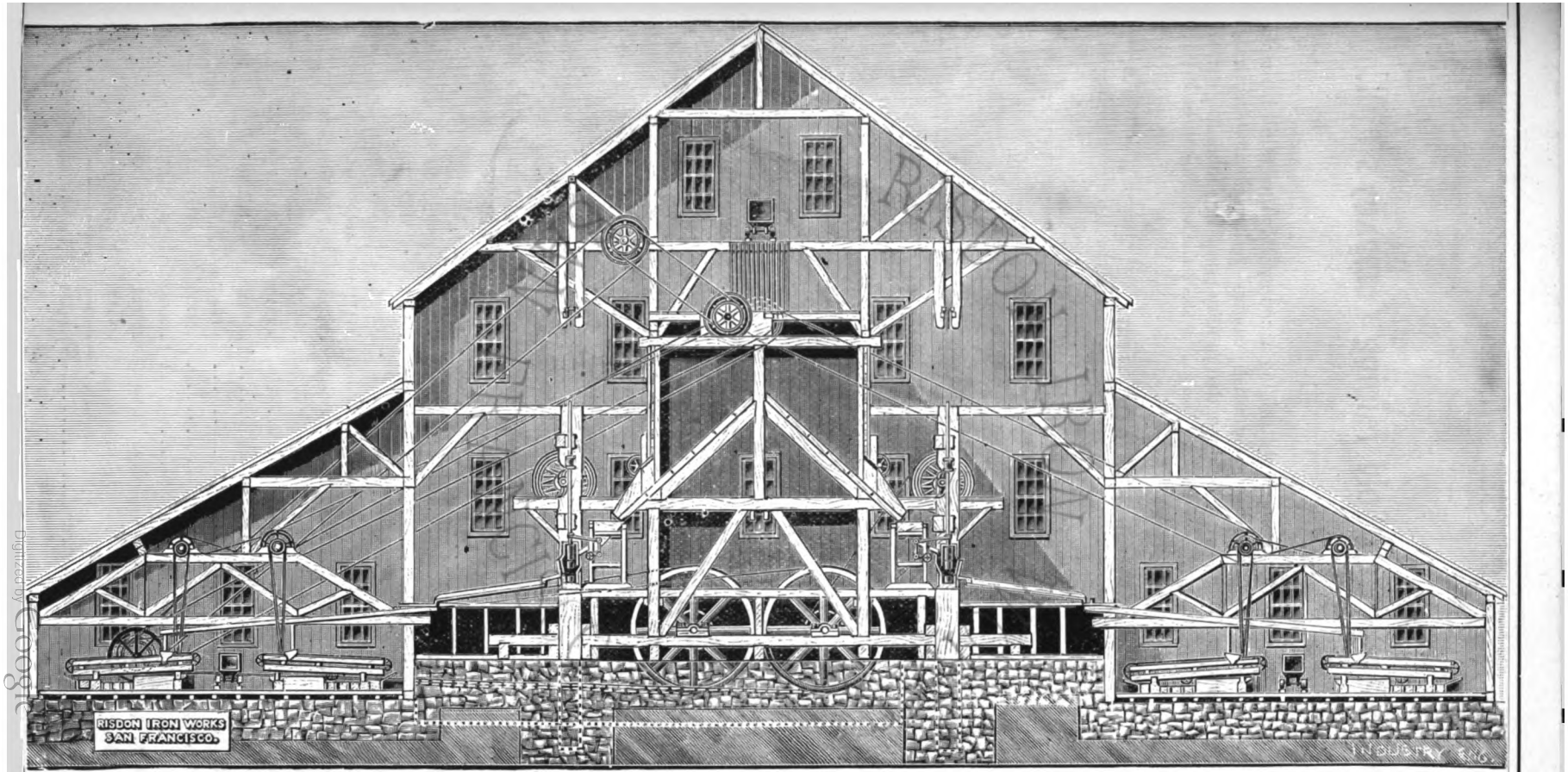


Plate 5.

SECTION OF THE ALASKA TREADWELL GOLD MINING CO'S 240 STAMP CONCENTRATING GOLD MILL.

THE LARGEST MILL IN THE WORLD. BUILT BY THE RISDON IRON WORKS.

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Alaska Treadwell Gold Mining Company's Mill.

We give a copy of this company's milling account, which we think is a very good record and would state that we furnish stamp mills for any capacity, which, under similar conditions, can be depended to fully equal this record.

This table is for one year.

MILLING ACCOUNT.

263,670 tons crushed. 4,373⅛ tons concentrates saved.

LABOR.	Cost per ton.		
Foreman and assistant	$0.0162	$4,274 12	
Carpenters	.0117	3 094 12	
Amalgamators	.0192	5,064 74	
Feeders	.0302	7 954 02	
Concentrators	.0288	7,589 30	
Oilers	.0073	1,932 62	
Crushers	.0142	3,744 89	
Ditchman	.0171	4,497 35	
Laborers	.0002	65 08	
Total milling labor	$0.1449		$38,216 24
SUPPLIES.			
Battery shoes, 572, 84,697 lbs	$0 0240	$6,334 67	
Battery dies, 480, 67,225 lbs	.0173	4,559 66	
Concentrator extras	.0115	3,022 13	
Screens, 1,300 square feet	.0021	548 50	
Mortars, two	.0018	470 00	
Transmission rope, 1,853 lbs	.0009	240 16	
Lumber, 76,401 feet	.0038	1,010 82	
Coal, 167½ tons	.0045	1,186 37	
Assay office account	.0010	255 57	
Electric light account	.0034	897 31	
Car account	.0015	385 22	
Repair account	.0170	4,486 91	
Steam power account	.0748	19,725 88	
Feeder extras	.0021	558 20	
Boss heads, 12	.0009	248 75	
Quicksilver, 48 flasks	.0074	1,942 00	
Mortar liners, 58,058 lbs	.0143	3,783 13	
Lubricants, 644 gals	.0006	163 71	
Lubricants, 2,389 lbs	.0009	235 35	
Cam shafts, 3	.0011	297 00	
Belting, 439½ feet	.0011	290 10	
Amount carried forward	$0.1920	$50,641 44	$38,216 24

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MILLING ACCOUNT—Cont'd.

	Cost per ton.		
Amount brought forward	$0.1920	$50,641 44	$38,216 24
Crusher extras	.0070	1,843 59	
Clean-up barrel and balls	.0005	128 96	
Rope sheaves, two, 2,887 lbs	.0007	180 07	
Rope, 1,081 lbs	.0005	128 48	
Mortar aprons, 3,311 lbs	.0006	135 33	
Guide blocks, 120 pair	.0004	114 00	
Miscellaneous	.0005	142 16	
Babbit metal, 256 lbs		33 76	
Lace leather, 114½ feet		28 26	
Coal oil, 330 gals		82 00	
Waste, 488 lbs		44 68	
Mill and whisk brooms, 116		28 50	
Screws		27 78	
Pipe Fittings		32 46	
Bolts, assorted		35 80	
Nails, 1,464 lbs	.0025	68 45	
Candles, 760 lbs		84 50	
Shovels, 14		15 05	
Concentrator extras		92 50	
Guide blocks extras		20 00	
Hose, 250 feet		62 50	
Handles, assorted, 39		7 05	
Glass and putty		9 87	
Cyanide of potassium		11 75	
Water-wheel buckets		24 50	
Zinc, 1,025 lbs		55 05	
Shingles, 2,500		6 00	
Torches and lanterns		6 05	
Tools	.0009	13 05	
Russia iron buckets, 6		16 00	
Set screws, 12		3 00	
Tallow, 501 lbs		26 50	
Packing, 262 lbs		79 55	
	$0.2056	$54,228 64	
Less sales through merchandise	.0029	773 54	
Total milling supplies	$0.2027		53,455 10
Total milling labor	.1449		
Total milling costs	$0.3476		$91,671 34

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Cheap Milling and Mining.

(Extract from Mining and Scientific Press.)

At the request of the editor, S. R. Porter, Superintendent of the Baliol Gold Mining Company, at Sutter Creek, Amador County, California, has sent the following interesting and valuable data as to the low cost at which mining and milling may be done under careful management and favorable conditions:

To the Editor:—I have your favor of the 21st inst, making inquiries for publication in the *Mining and Scientific Press* of the cost of mining and milling ore by me as Superintendent for the Company. Knowing that data of actual runs and expenditures are of great interest to those who are engaged in the mining industry, to them I most cheerfully submit the following:

The ore was excavated from an open cut 75 x 125 feet, from which it was dumped into a chute and trammed 700 feet to another chute, where it was again trammed 800 feet to ore bin at mill, thus requiring the ore to be handled twice and trammed a distance of 1,500 feet.

No timbers have been used thus far in the cut.

The mill which I operate is forty stamps, of 1,000 pounds each, with a 4-inch drop, making 102 drops per minute, with a 9-inch die. Forty-mesh perforated tin screens are used in batteries to plates. The mill was closed down sixty hours during the month of April.

The following is a copy of my report as transmitted to the President of the Company for the month of April, 1897:

THE COST OF MINING FOR APRIL.

534 days labor mining	$1,145 50
25 days blacksmith, sharpening	60 00
1,275 lbs. powder	102 00
5 boxes caps	2 50
2,200 feet fuse	11 22
30 days lighting, miners' candles	7 50
310½ days labor tramming ore	647 12
30 days lighting, trammers' candles	7 50
5 gallons coal oil for lamps	55
Oil for cars	2 83
Total cost of mining and delivering 5,885 tons of ore	$1,986 72

MILL REPORT.

I had in ore bin on May 1st 300 tons of ore, which was the same amount brought forward the previous month. This will give me the full 5,885 tons as mined also worked in the mill.

THE COST OF MILLING FOR APRIL.

118½ days labor on batteries and plates	$ 362 00
61½ " " concentrators	168 00
44 " " rock crushers	101 25
94 " " ore bin	188 00
Mill repairs	161 27
Mill expense	60 12
Mill lighting	26 06
Power water supply for April	480 00
Total cost of running mill for April	1546 70

Cost of mining and delivering 5,885 tons of ore....$1,968.72@.33$\frac{14487}{5885}$ per ton
Cost of milling 5,885 tons of ore..... 1,546.70@.26$\frac{1660}{5885}$ " "

Cost of mining and milling.....$3,533.42@.60$\frac{2347}{5885}$ per ton

Yours respectfully, S. R. PORTER, Superintendent.

It will be observed that forty stamps crushed 5,885 tons of rock in twenty-seven and a half days, or an average of 5.35 tons per stamp each twenty-four hours.

The above mill was built by the Risdon Iron Works.

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A GRIZZLY

Very much resembles an ordinary iron grating, made from special bar iron, as rolled for grate bars, having their thick edges on top, and bound together with bolts and mesh thimbles of cast iron.

The Grizzly is built in the woodwork above the ore bin, at an angle of 35 to 40 degrees, and walled on its sides with planks.

All the ores brought to the mill are dumped on the Grizzly; the parts too coarse to be fed to the battery are delivered on the rock breaker platform, or in feed hopper.

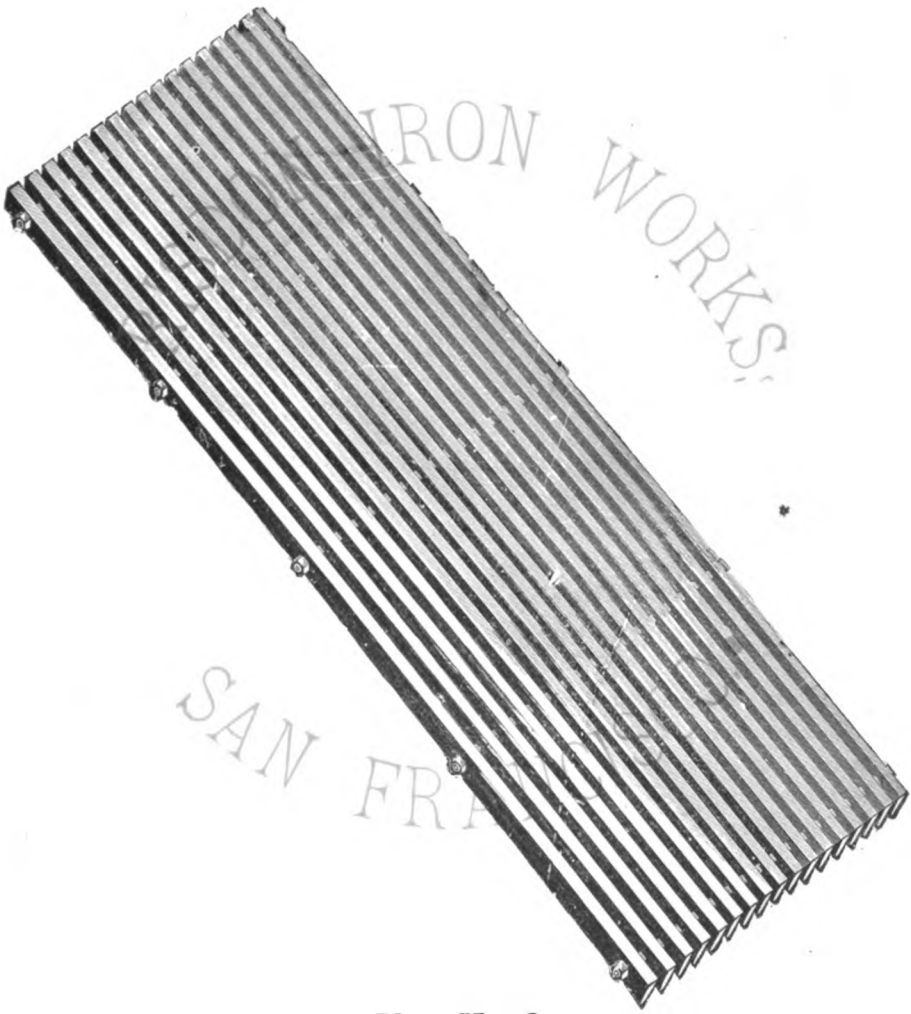


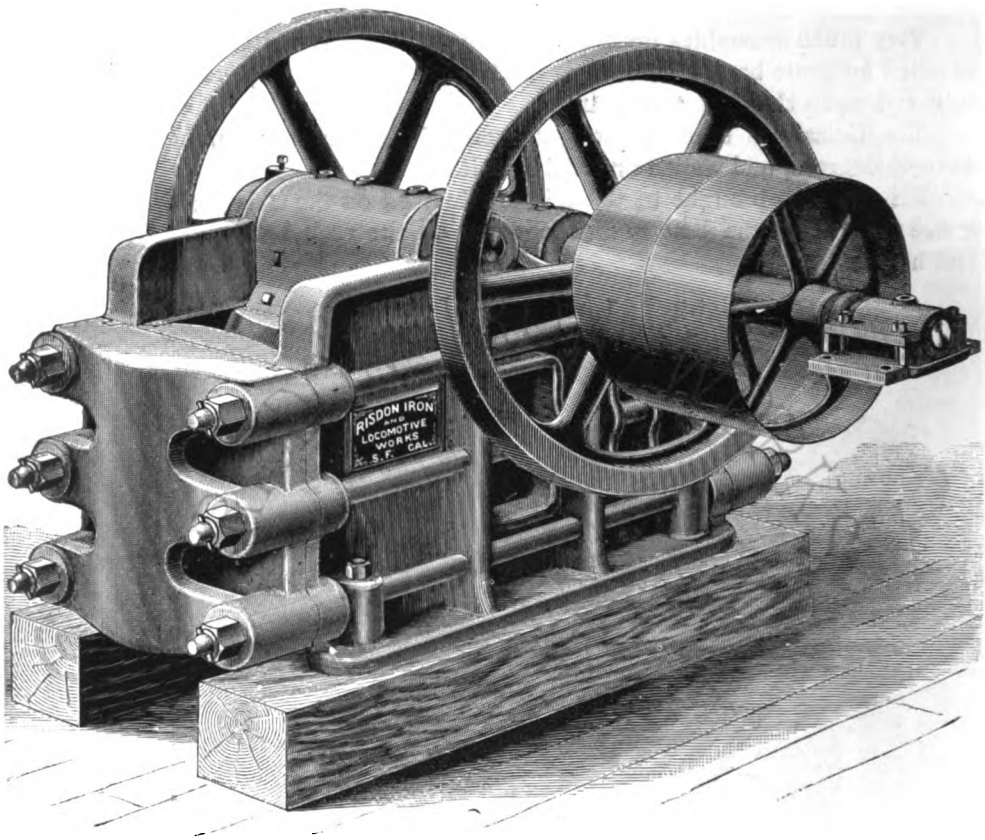
Plate No. 9

We manufacture these of any required mesh and size

STANDARD SIZES

No.	Size of Grizzly Inches	Size of Bars Inches	Mesh Inches	Weight Lbs.	Price
1	5 x10	¾x4	2¼	2340	$
2	4 x12	¾x3	2	1650	
3	4 x10	¾x3	2	1580	
4	4 x10	¾ and ½x3	1	1800	
5	3½x10	½x2	1	1020	

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The Improved Blake Rock Breaker.

We illustrate above an improved and simplified form of the well-known Blake Rock Breaker. This machine is too well known to require extended notice. The bolts which take the crushing strain pass outside of side frames and run the whole length of the machine, thus making the frame very strong and rigid. Two pull back springs are provided instead of one, thus giving a better effect and reducing liability to breakage. The shoe, die and toggle seals are made of cast steel, and eccentric shaft of forged steel. The design metal and proportions throughout have been determined from actual practice, and with the other improvements make this an unusually strong and efficient machine.

TABLE OF STANDARD SIZES.

Size No.	Jaw Opening for Receiving Rock.	Capacity in tons per hour, Jaws Set 1½"	Extreme Dimensions. Length ft.	Length in.	Breadth ft.	Breadth in.	Driving Pulley. Diam., in.	Face, in.	Weight Heaviest Piece.	Weight Complete.	Horse-power Required.	No Revolutions per Minute.	Price
1	7 x 9	4	4	2	3	6	20	6½	300	2,700	4	275	$ 300
2	8 x 12	6	5	0	4	0	24	8½	500	4,900	5	250	500
3	9 x 15	10	5	8	5	0	30	8½	1,150	8,000	8	250	800
4	13 x 18	15	9	0	7	6	36	10½	2,900	25,000	20	200	2,400

No. 2 made in 300-pound sections; $50.00 extra.

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Dodge Improved Rock Breaker

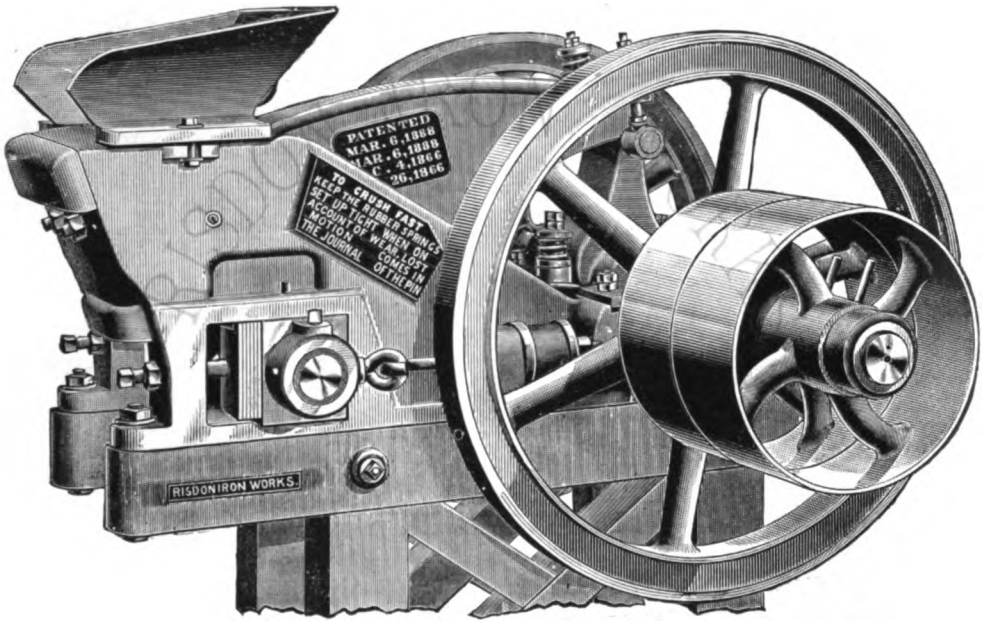


Plate 19

Number	Size	CAPACITY	Weight of Heaviest Piece	Total Weight	Extreme Dimensions			Driving Pulleys, Tight and Loose		Proper Speed	Horse-Power	PRICE
					Length	Breadth	Height	Diam.	Face			
					Ft. In.	Ft. In.	Ft. In.	Ft. In.	Ft. In.			
1	8x12	4 to 6 tons per hour or twenty Stamps.....	2,100	4,600	4 . 6	5 . 3	4 . 0	2 . 0	0 . 8	250	7	$500
2	7x8	3 to 4 tons per hour or ten Stamps.....	912	2,200	3 . 9	3 . 7	3 . 0	1 . 4	0 . 6	300	5	300
3	6x6	1 to 2 tons per hour or five Stamps.....	360	1,200	3 . 0	3 . 0	2 . 0	1 . 0	0 . 5	350	3	150

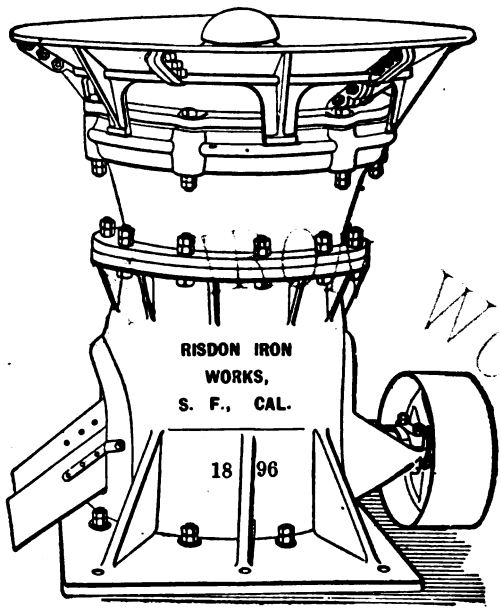
This Breaker should be ordered when fine crushing is desired. Our system of construction provides in this Breaker for ready, positive adjustment for finer or coarser particles as desired. We make No. 2 Breaker in sections so that it can be carried on mules. No. 3 can also be packed. We carry all the above sizes in stock, and are prepared to furnish them at short notice.

We make the above Rock Breakers with or without " Pin Plates " as desired.

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"RISDON" GYRATORY CRUSHER.

GREATEST ON EARTH.



PRICES, DIMENSIONS, WEIGHTS, CAPACITIES AND REQUIRED POWER.

Size.	Dimensions of each receiving opening about. Inches.	Dimensions of three receiving openings combined, about. Inches.	Weight of Breaker. Pounds.	Capacity per hour, in tons of 2,000 lbs., passing 2½ in. ring, according to character of rock or ore.	Dimensions of Driving Pulley. Diam., inches.	Face, inches.	Revolutions of Driving Pulley.	Size engine recommended to drive breaker, elevator and screen. Indicated Horse-power.	Prices subject to change without notice.
00	2 x 4	2 x 12	350	.....	8	2⅝	700	1 to 1½	$ 100
0	4 x 10	4 x 30	3,000	2 to 4	16	6	500	4 " 5	375
1	5 x 12	5 x 36	5,500	4 " 8	20	7	475	8 " 10	550
2	6 x 14	6 x 42	8,000	6 " 12	24	8	450	12 " 15	760
3	7 x 15	7 x 45	14,000	10 " 20	28	10	425	20 " 25	1,200
4	8 x 18	8 x 54	21,000	15 " 30	32	12	400	25 " 30	1,800
5	10 x 20	10 x 60	29,000	25 " 40	36	14	375	30 " 40	2,500
6	11 x 24	11 x 72	40,000	30 " 60	40	16	350	40 " 60	3,300
7	14 x 30	14 x 90	61,000	50 " 125	44	18	350	75 " 125	5,000
8	18 x 42	18 x 126	90,000	100 " 150	48	20	350	100 " 150	7,000

The above prices do not include foundation bolts.

The mechanical construction of this form of Risdon breaker is without doubt the finest ever made. It is a breaker of the gyratory form. The word gyratory partially explains the mechanism. The crushing is done between a cone placed on a gyratory shaft vertical through the center of a cylindrical shell. As it gyrates, the crushing cone impinges against the sides of the shell, in relation to which it is constantly approaching and receding. The top of the shaft carrying the crushing cone is held rigidly, while the bottom is gyrated (with a certain amount of eccentricity, depending upon the size of the machine) by means of a simple gearing.

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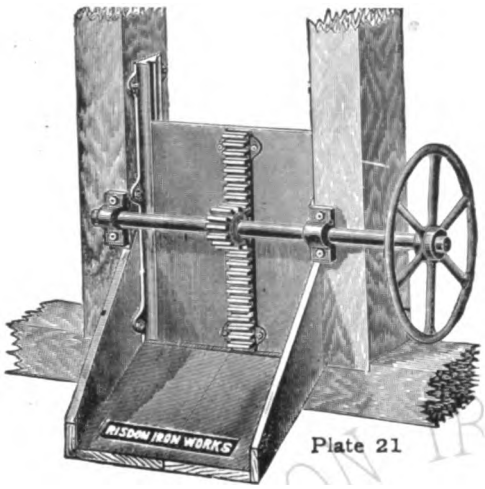


Plate 21

ORE BIN GATES

This cut shows an Ore Bin Gate, attached to an ore bin, its inclined bottom being an extension of the floor of the Ore Bin.

Ore Bin Gates are used in mills to supply Automatic Ore Feeders, and sometimes Rock Breakers.

The larger sizes are used in mines and on railroad tracks to load cars, and are indispensible in systematic mining and milling.

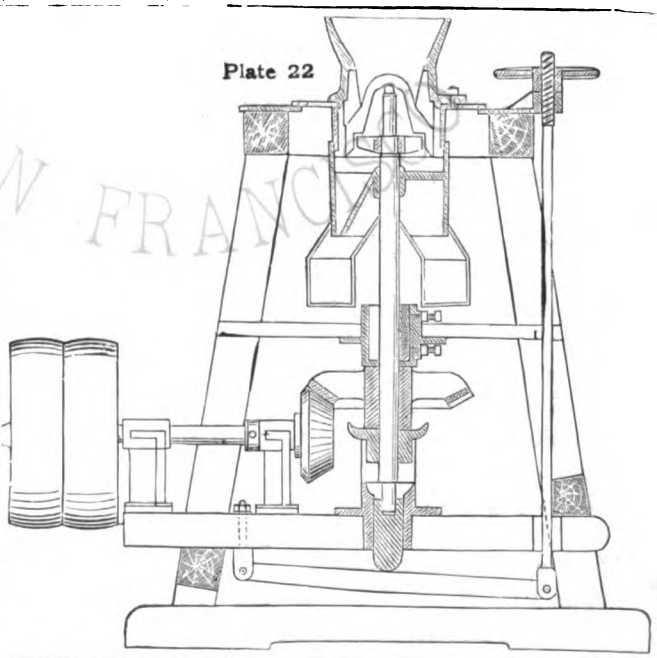
TABLE OF STANDARD SIZES

Trade No.	Width	Height	Thickness of Door	Weight	Price
1	12 ins.	18 ins.	¼ in.	130	$
2	18 "	24 "	¼ "	150	
3	24 "	30 "	¼ "	285	
4	24 "	42 "	¼ "	385	

ORE SAMPLER AND GRINDER.

SAMPLE GRINDER.

This is a very useful machine in any works, and is especially necessary in a Custom Mill. The coarsely crushed sample for assay is rapidly ground to fine powder and is caught below in pans from two spouts, the distributing case and spouts being closed in so no dust can get out of the machine. Also a splendid machine to regrind small quantities of sulphurets.


Plate 22

Speed	Diam. of Pulley, Tight or Loose	Face of Pulley	Weight Not Boxed	Weight Boxed	Price
150	16 in. Diam.	4½ in. Face	500 lbs.	700 lbs.	$150

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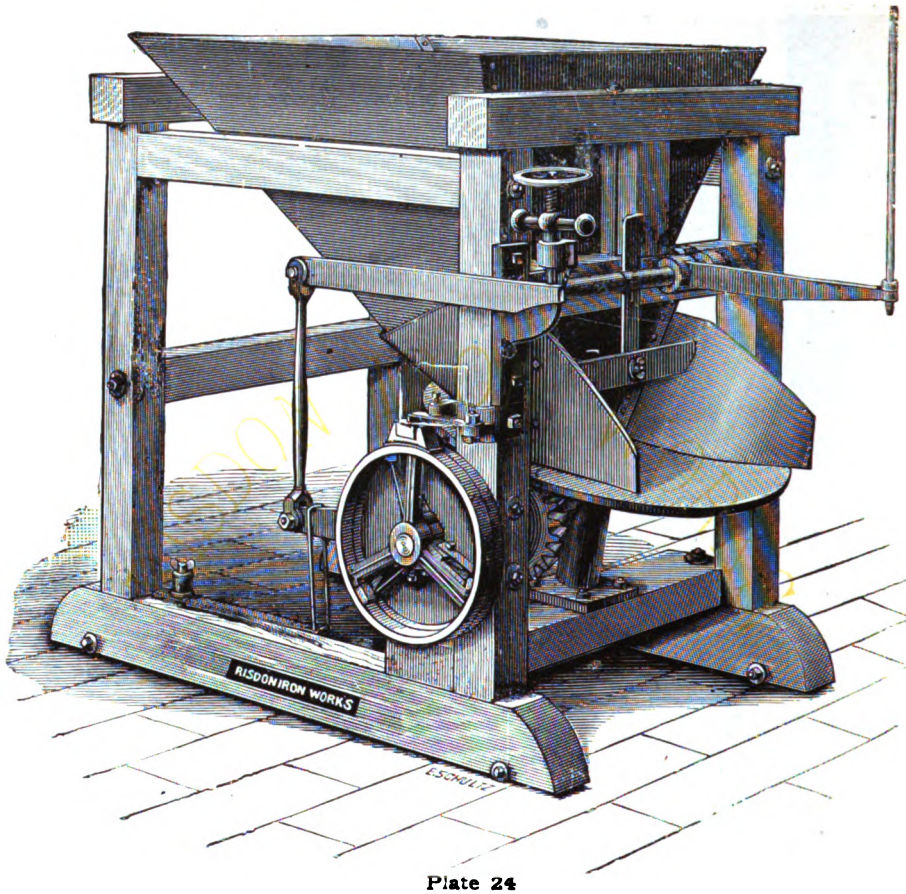


Plate 24

RISDON CHALLENGE ORE FEEDER

When batteries were fed by hand it required the labor of three men to feed twenty stamps twenty-four hours.

Now four automatic Ore Feeders perform the same work (with an occasional visit from the batteryman), increasing the capacity of the battery from ten to twenty per cent over hand feeding. At the same time saving considerable loss from breakage of screens and stamps, resulting from the inattention of hand feeders.

It is evident that the Ore Feeder occupies a very important place in a quartz mill, and that it is also important to have a feeder which can be relied upon to feed the required amount of ore to the battery at the proper time, whether the ore happens to be wet or dry, sharp hard ore, or mixed with clay and moisture.

Twenty years of practice with self feeders has taught the mill man that the ore *must* be "carried" to and deposited in the mortar with uniform certainty in any of the conditions named above.

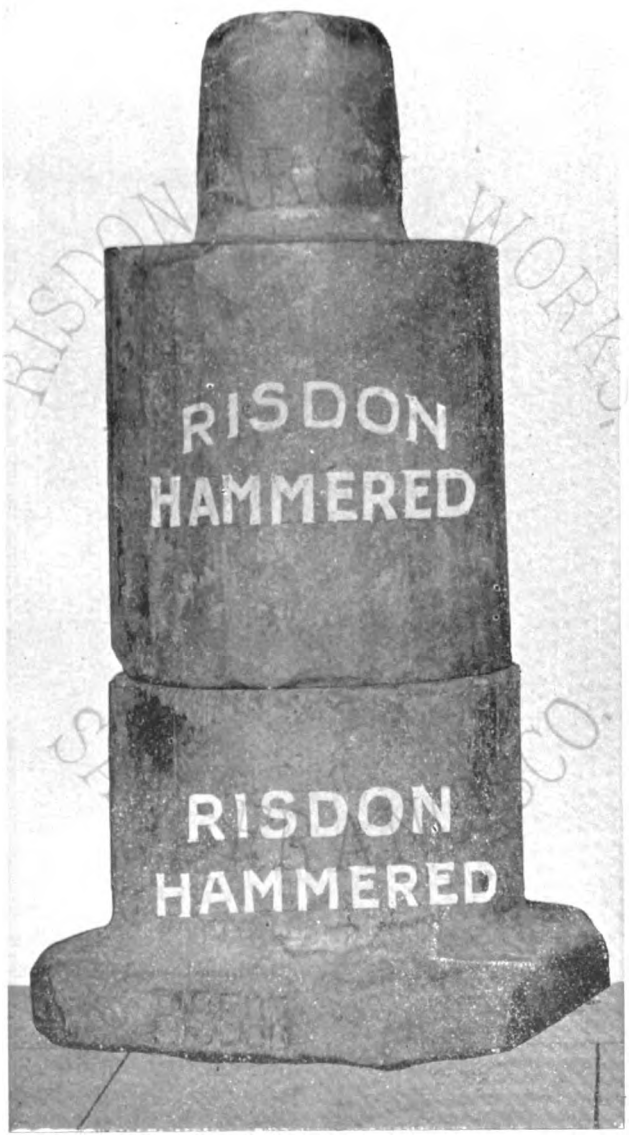
The "Challenge" Ore Feeder is particularly adapted to feeding wet or sticky ores, and can be relied upon to feed all kinds of ore, when properly adjusted.

These feeders are in use in nearly all the leading mining districts and are considered a standard feeder.

Shipping weight..... 875 lbs.

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RISDON
Hammered or Forged Steel
SHOES AND DIES.



THE RISDON IRON WORKS

SOLE MANUFACTURERS

SAN FRANCISCO CALIFORNIA.

1897

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CLIFFORD, BAKER CO., Oct. 21, 1896.

The Risdon Iron Works, San Francisco:

GENTLEMEN: Please make us forty (40) more of your hammered steel shoes and dies. We are very well satisfied with the last set you furnished, which have been in continuous use for 147 days. Please get these shipped as soon as possible.

Yours truly,

(Signed.) ALBERT GEISER,
Manager Bonanza Mine.

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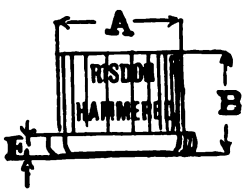
RISDON
Hammered or Forged Steel
SHOES AND DIES.

Our illustration shows the best shoe and die ever made, and we take pleasure in giving a few particulars regarding them.

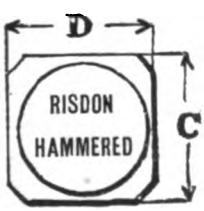
We have, at great expense, fitted up a special department at our works exclusively for the manufacture of shoes and dies, using a special 5,000-pound steam hammer striking a blow of ten tons. The steel blooms are forged from twelve inches square down to the proper size and shape. They are then driven in special molds to give exact shape and to smooth up the bottom of dies. We also drive over the necks a turned tool which straightens them and brings the shoe and die perfectly in line after they are finished. They are placed in a soaking furnace and given a slow heat which makes each set exactly the same temper.

Our shoes and dies will crush more ore per pound steel than any other. The life of a shoe and die depends on the number of tons crushed, not on the number of days used, as a badly cupped shoe and die will continue to drop in battery without doing any work. Our shoes and dies will not cup or chip, and will outcrush any other.

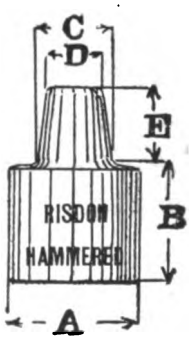
Note testimonials on next page. Fill in sizes and send us an order. Prices as low as a first-class article can be sold for. We have our shoes and dies running 225 days, which is exceptionally long, and in 500 shoes and 500 dies made by us the average life was 125 days.



A=.....inches.
B=.....inches.



C=.....inches.
D=.....inches.
E=.....inches.



A=.....inches.
B=.....inches.
C=.....inches.
D=.....inches.
E=.....inches.

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K. W. MIDOWICZ, M. D.,
PRESIDENT

ORIGINAL QUARTZ HILL GOLD MINING CO.

Middle Creek, Shasta Co. Cal., April 6th 1896

The Risdon Iron & Locomotive Works,

San Francisco.

Gentlemen:--

I am very much pleased with the "Risdon" Hammered Steel shoes and Dies and want another set for our 20 stamp mill. We have never had shoes and dies last as long; the last set was only 1/4 inch thick on shoe and 1/2 inch thick on die when removed,-- and no sign of chip, crack or cupping.

Yours truly,

K. W. Midowicz

Principal Office 201 California St. Cor. Sansome S. F. Robert Walker, Superintendent

Original Empire Mill & Mining Company.

Location of Mills Grass Valley Nevada Co. Cal

Grass Valley, Nevada Co, Cal. Sept 21st 1896

Risdon Iron & Loc. Works
San Francisco Calif.
Dear Sirs

In answer to your letter of the 7th inst, in regard to your battery shoes, will state that we have used your Hammered shoes for four months, and that they are good for two months more at least, they give us good satisfaction.

Yours Respy
Robert Walker Supt.

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FIVE AND TEN STAMP BATTERIES

Plate No. 23 illustrates a five and a ten stamp battery as they appear when erected for wet crushing.

The battery frame shown in the plate is known as the "A" frame, and is not much used, having been superseded by the more modern "knee" frame, which is now more generally used. For description of the "knee" frame see plate No. 75.

The "A" frame battery has its countershaft on the sills nearly under the cam shaft, and its driving belt runs vertically. A suitable tightening pulley is used to start and stop any battery at pleasure.

The "knee" frame battery has its countershaft on a level with the cam shaft; each battery is driven by a friction clutch pulley on the countershaft, to provide for starting and stopping it independent of the motive power.

The "knee" frame also carries a floor convenient for inspecting and repairing the batteries, and for "hanging up stamps," etc.

The general design and construction of a dry crushing battery is similar to the wet, except that the former has a double discharge mortar and housings to confine the dry pulverized ore as it passes from the mortar to the conveyor ta each side of the battery.

Battery frames and ore bins should not be framed together, except when occupying a common, solid foundation.

Our plans and patterns embrace all the regular sizes of stamps, from 250 pounds to 1000 pounds each, with complete batteries to correspond.

Unless otherwise specified, all estimates include iron shoes, dies, cams and tappets.

In many cases steel shoes and dies are used with iron cams and tappets; in other cases mill men require *all steel*, or steel shoes, dies, cams and tappets.

All parties applying for prices, or ordering battery machinery, should distinctly specify how many parts they desire to have made of steel, and also the weight of stamps they prefer, weight of mortar, and kind of guides required. Such information enables us to furnish a more intelligent estimate, and often saves time in writing for particulars.

We usually estimate the speed of cam shafts at 48 revolutions per minute, giving the stamps 96 drops per minute.

This speed seems to be a satisfactory standard, although our cams will run up to 105 six inch drops per minute without "striking," and in some of the largest mills 950 pound stamps have been continuously run at 100 drops per minute with excellent results when a reliable governor is used.

It is claimed that there is economy of power in high battery speeds, caused by the cam engaging the tappet on the rebound of the stamp, and that this theory has been proved by extensive tests in the famous Consolidated Virginia and California battery mills.

With a shorter drop a much higher speed can be obtained, and an increase of drop requires lower speed in proportion to the increase given.

We build batteries of one, two, three or five stamps for prospecting mills, with single or double cams, as required.

The following specifications embrace all the parts usually included in our estimates for battery machinery for 10 stamps and 5 stamps. Specifications for any number of stamps may be prepared from the same table.

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FIVE AND TEN STAMP BATTERY.

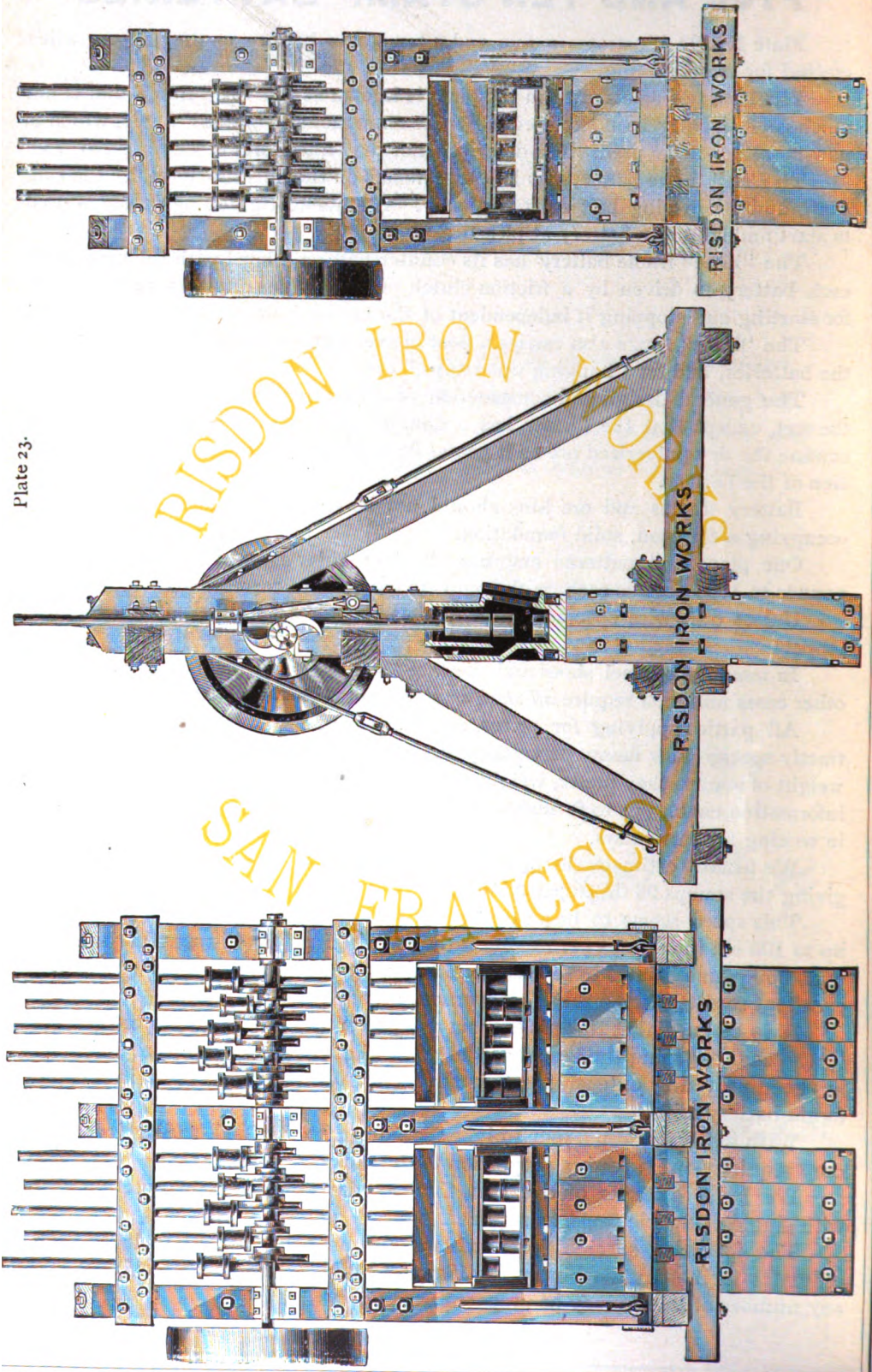


Plate 23.

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GENERAL SPECIFICATION

OF A

10-STAMP BATTERY

2 high mortars, of improved pattern, single or double discharge, planed on bottom.

2 screen frames of soft pine, fitted to mortars.

2 screens, steel wire or punched.

8 gib-headed keys for screen frames.

2 sheets of rubber for mortar cushions.

10 stamp dies.

10 " shoes.

10 " heads, bored for stems.

10 stems of refined iron, both ends tapered.

10 tappets, each to have wrought iron gib and two steel keys.

10 cams, right and left hand, hubs banded and fitted to shaft with steel keys.

1 cam shaft of hammered iron, turned and seated and marked for each cam.

3 cam shaft boxes, bored and planed on bottom and back.

2 wrought iron cam shaft collars, with steel screws.

1 pair cast-iron sleeve flanges, and wood pulley 72 in. by 16 in., built up of clear seasoned pine, and fitted to flanges, which are to be fitted to shaft.

2 upper and 2 lower hardwood guides, bored for stems, with bolts.

2 W. J. jack shafts.

4 C. J. " bearings, with lag screws.

10 latch sockets for finger bars.

10 wood finger bars, mounted complete.

1 set of water pipes, valves and fittings, as required by our plans within mill.

All bolts, nuts, rods and washers for a 10-stamp battery frame, complete.

1 steel key for loosening shoes and stamp heads.

For specification of a **5-Stamp Battery**, take—

1 cam shaft.

2 " boxes.

2 " pulley flanges and 1 pulley.

1 set of water pipes, bolts, nuts, washers and keys.

All other parts equal one-half of the above specification.

For specification of a **20-Stamp Battery**, double that of 10 stamps.

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CROSS SECTIONS OF VARIOUS MORTARS

Plate 26

Fig. A illustrates our standard steel lined, single discharge, wet crushing mortar.

This mortar is extra heavy and provided with steel linings in sections, which, when worn, can be removed at a slight expense, very much increasing the life of the mortar. It is also furnished with a special apron made separately, and as shown bolted to mortar in cut.

Ordinary inside copper plates can be used on screen frames, when desired.

The feed opening is long and placed at the usual height.

The capacity of a battery largely depends on the construction of the mortar, and our patterns are designed to give the best possible results in all cases.

Fig. B is a cross section of a gold mortar provided with space for an inside, back amalgamating plate protected from scouring by an apron at the base of feed opening, and immediately above the plate.

A special door, secured with a lock, is provided in the back of mortar, affording access to this plate and chamber.

The usual inside copper plate on screen frame can also be used, if desired.

Fig. C differs from B in that it has no back door; it is provided with a recess for an inside back amalgamating plate, and a protecting apron for the same as in fig. C.

Fig. D is another gold mortar of the same type, in which the inside back amalgamating plate is secured to a piece of wood fitted to the mortar, and keyed in place with wood keys.

Fig. E is our regular double discharge mortar, used chiefly in dry crushing mills.

It is well known that a dry crushing battery has much less capacity than a wet one, for the reason that dry pulverized ore discharges slowly, and even with double discharge, their capacity is still much less than the wet mill. To obviate this difficulty the screen surface is enlarged as much as possible, and suction fans are employed to withdraw the pulverized ore.

In a few instances double discharge mortars have been tried in wet crushing mills, but with doubtful advantage.

Fig. F shows a cross section and part longitudinal section of our improved sectional mortar for either gold or silver ores.

The sections are carefully planed and dovetailed together, then with turned bolts fitted to reamed holes, the entire mortar is securely bound together. Steel plates and angle iron make up the sides and ends.

These mortars are made for packing on mules over mountain trails; the heaviest piece is not over 300 lbs.

They are as tight and durable as the solid mortar.

We make mortars of any desired weight or thickness of bottom, and always plane the bottom unless otherwise ordered.

We also make mortars for one, two or three stamp prospecting batteries.

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VARIOUS MORTARS

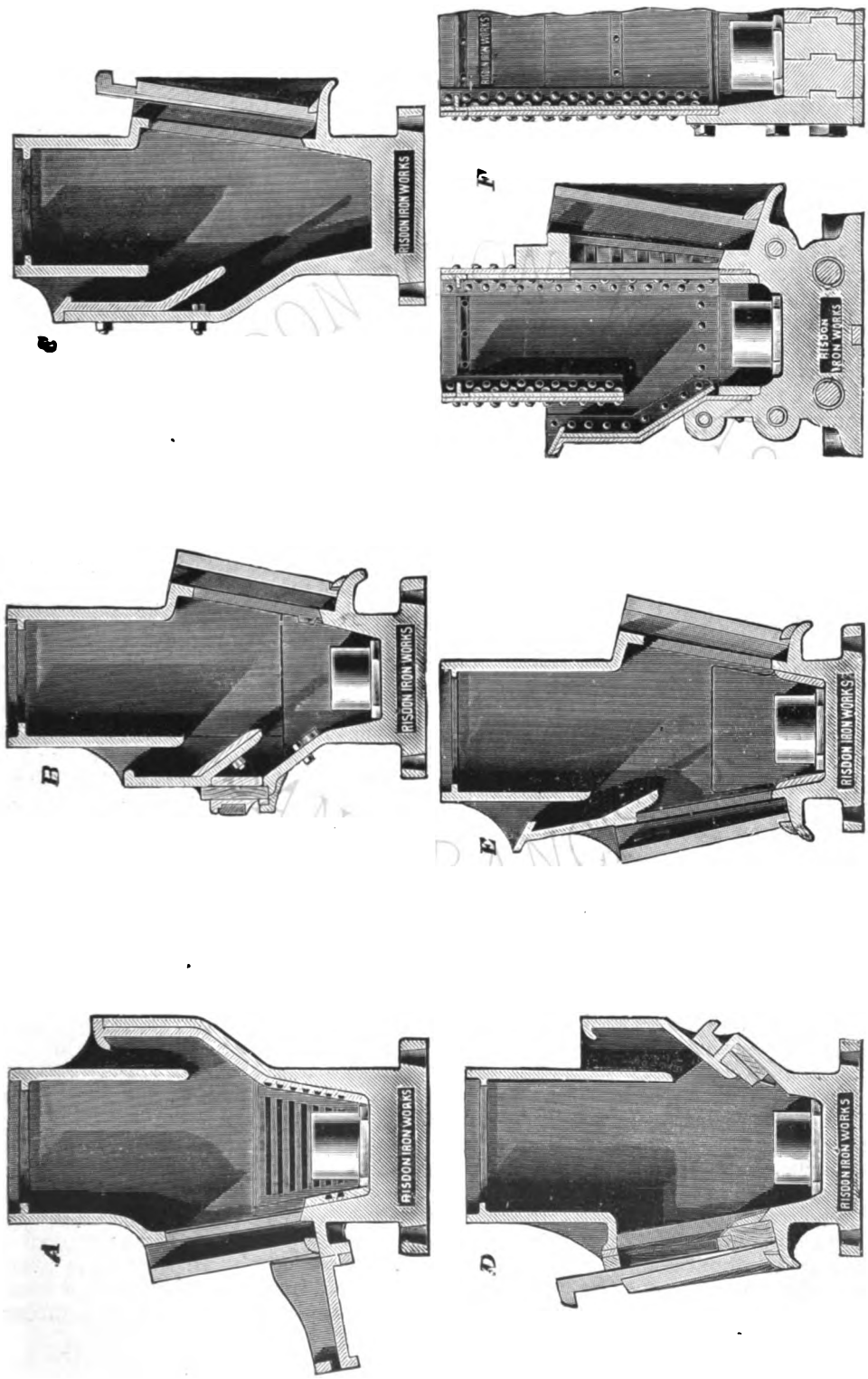


Plate 26.

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BATTERY DETAILS

Plates No. 27 and No. 29 give details of batteries, with reference letters and dimension points, to enable parties ordering any of these parts to do so without being misunderstood, thus preventing unnecessary delays and mistakes.

A is the "cam shaft," mounted with driving pulley and cams arranged in position, as used in a 10-stamp battery.

The "stamps" will drop in the order of the figures 1, 2, 3, etc. (the drops occurring alternately in mortars 1 and 2), arranged in this manner so as to insure the proper distribution of ore in the mortar, and as nearly as possible a uniform tension on the belt.

The best form of a cam is a modified involute of a circle, the radius of which is equal to the horizontal distance between the center of cam shaft and the center of stem. The modification consists in sharpening the involute curve near the point of the cam.

"Cams" are made of selected iron or steel. "Cam shafts" are made of hammered iron. "Cams" are keyed to shaft with closely fitted steel keys. "Cam shaft pulleys" are built up of clear seasoned pine, bolted to a pair of nicely-fitted male and female "sleeve flanges." G, H and M are different forms of cam shaft boxes. G is a double "cam shaft box" to accommodate the end journal of two cam shafts, which meet on the same battery post. H is a single "knee box," bored or babbited as may be preferred. M is an improved form of "cam shaft box," designed by Mr. Boss. They are bored to fit the cam shaft, and are provided with a drip pan to collect the waste oil from the journals.

"Right" and "left" hand cams are clearly illustrated in the cut at CC. O is the standard two-keyed "tappet," fitted with steel gib and keys. They are counter bored at both ends, and rebored eccentric through the body of the tappet, to insure a firm grip on the smooth stem. N is a "3-keyed tappet," made longer than the 2-keyed one, but in other respects the same. The 3-keyed tappets are often preferred for heavy stamps. All tappets are made double ended, of selected iron, to insure the greatest strength and durability. R is a sectional view of a "stamp head," sometimes called "boss" or "socket." They are made with or without bands, as desired. Orders should state whether bands are required, or not. Stamp heads are made the same diameter as the shoes, and have tapered sockets to receive them. The tapered socket at the upper end to receive the stem is accurately bored to fit the taper of the stem. The shoe socket and shoe neck are made rough with an annular space between, to receive soft pine wedges, which secure the shoes in place. P is a battery shoe, made of hard iron or steel. S is a battery die, also made of hard iron or steel. The bases of the dies are made to suit the dimensions of mortar, and have the corners cut off to admit a bar to remove them when "cleaning up." Round base, dovetailed dies, are rarely used. H is a "battery stem" having tappet, stamp head, shoe and finger engaged as when the stamp is "hung up." The "stem" is made of soft iron tapered at both ends, so that it can be reversed and both ends used without welding. L is a wooden finger mounted with iron point, handle, and fixed in an iron socket, which rests on the "jack shaft." One jack shaft carries the fingers for five stamps. These are used only in case of "hanging up" the stamps. F is a plain wooden guide, such as is usually estimated on and sent out. They are usually made of maple; occasionally of Oregon pine. E is a combination guide, framework of iron and box linings of wood. The wood linings surround the stem as shown, and have the advantage of allowing any stem to be removed or replaced without disturbing the other stems. These cost more than plain wood, and are furnished only on application. D is an all iron guide, babbited or bored to fit stems. These have the same advantage mentioned above for the combination guide, the cap of each box being separate.

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BATTERY DETAILS

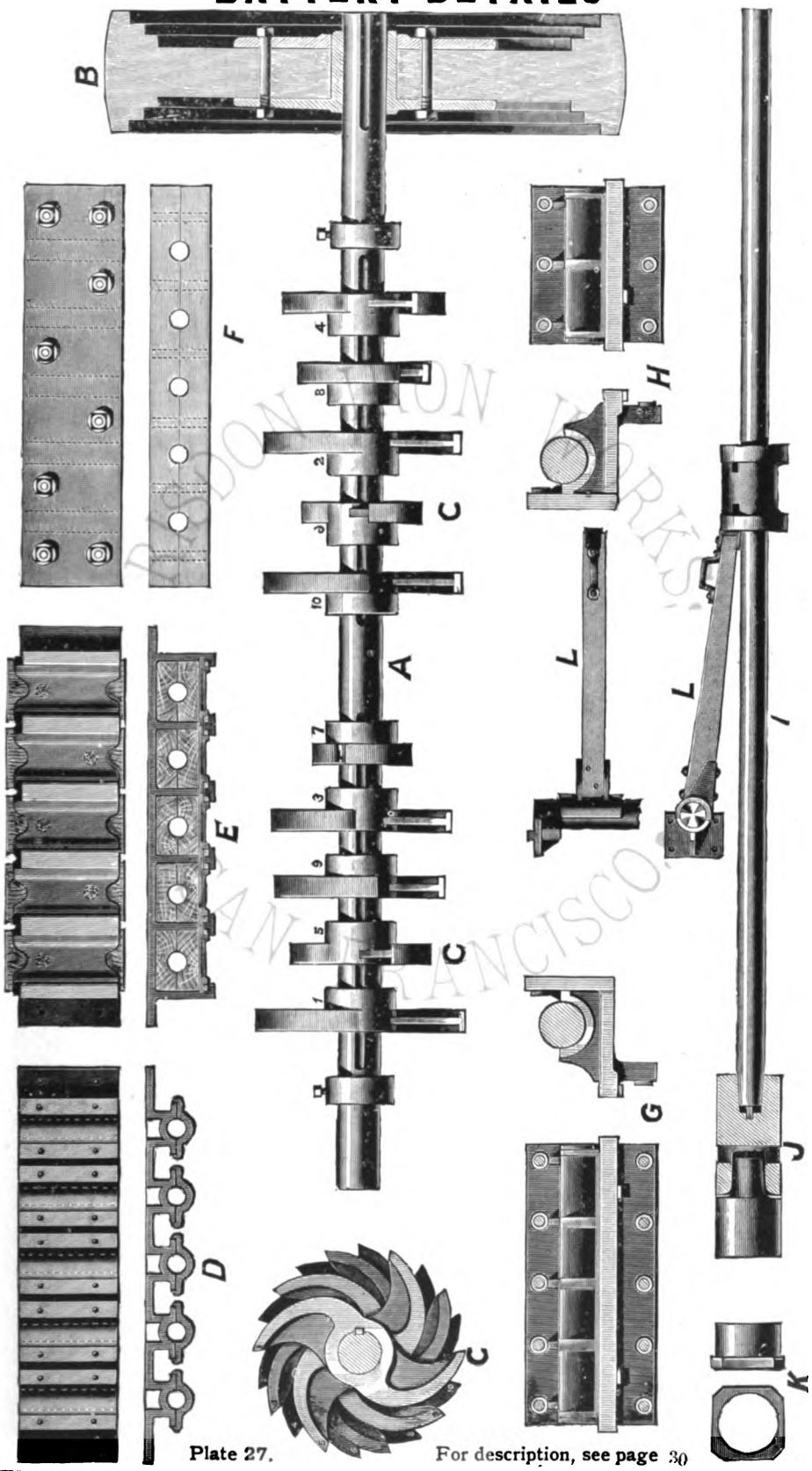


Plate 27.

For description, see page 30

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BATTERY DETAILS

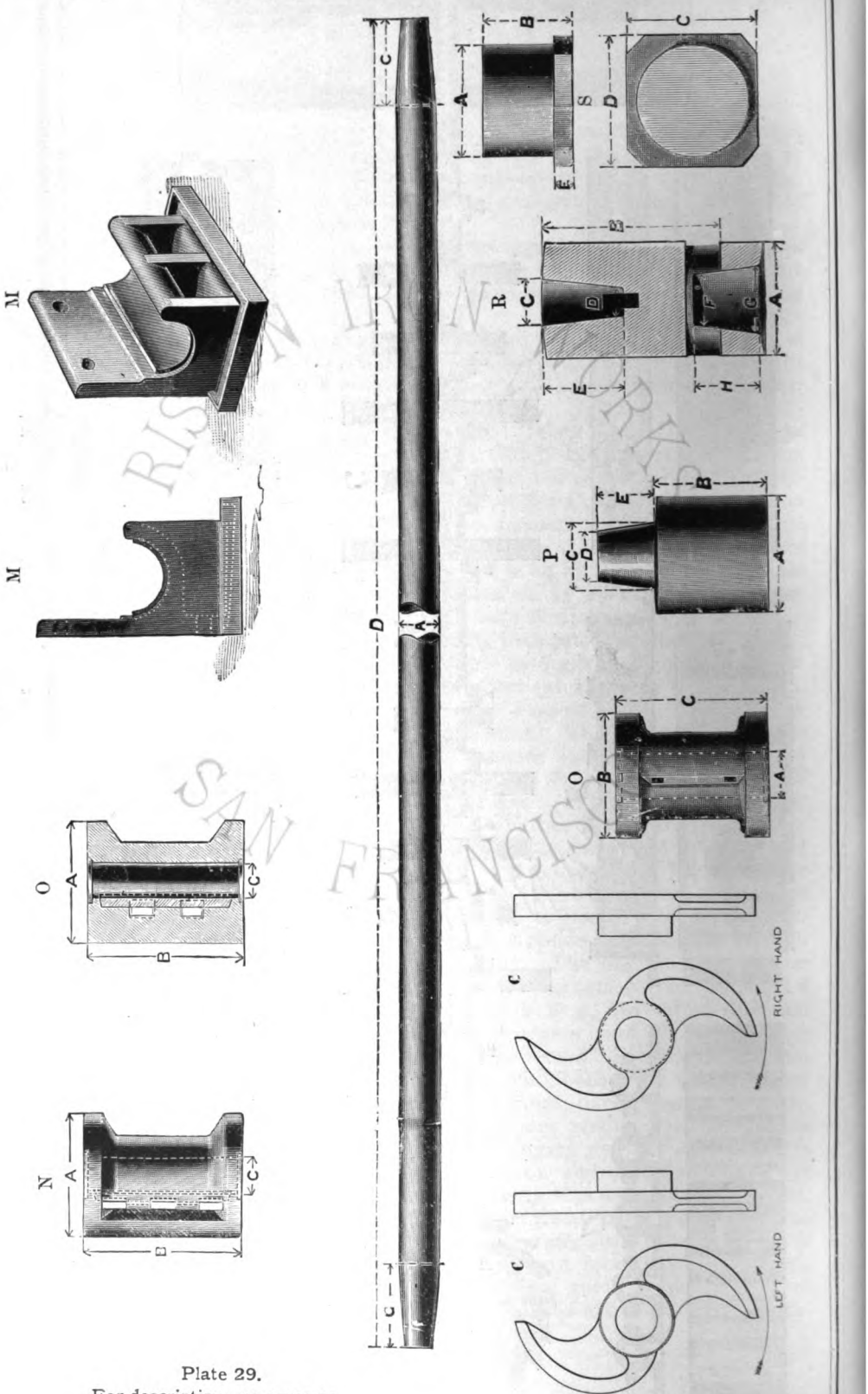
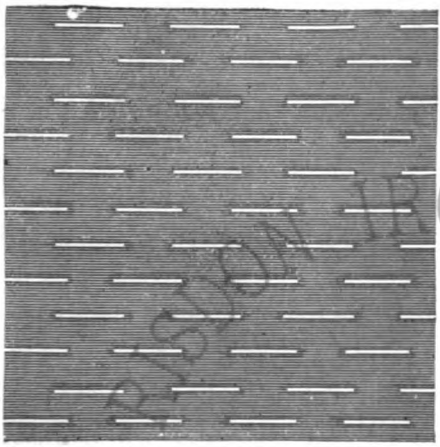


Plate 29.
For description, see page 30

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BATTERY SCREENS

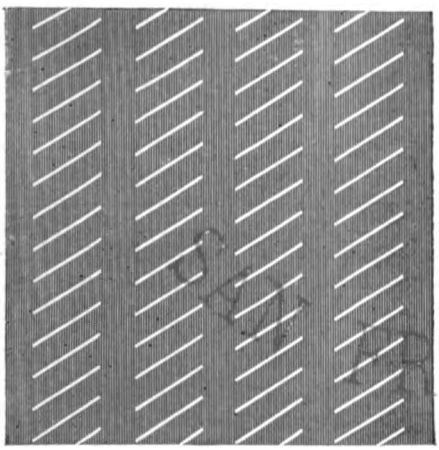
Plate 31



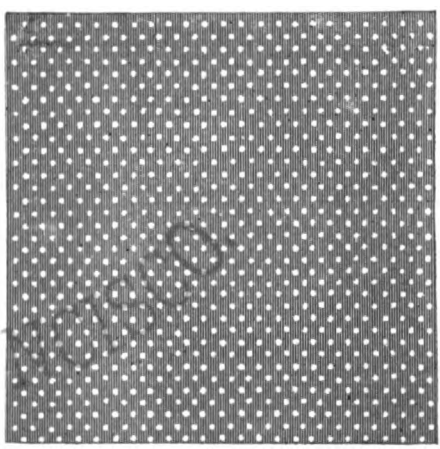
BURRED SLOT



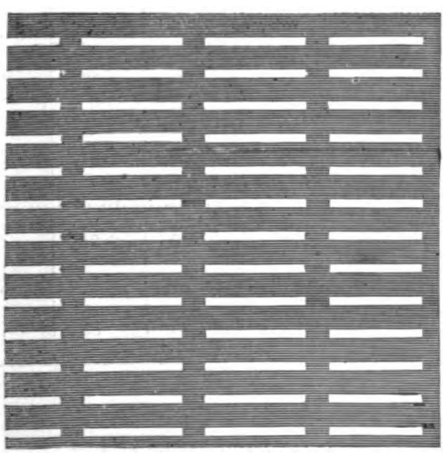
HORIZONTAL SLOT



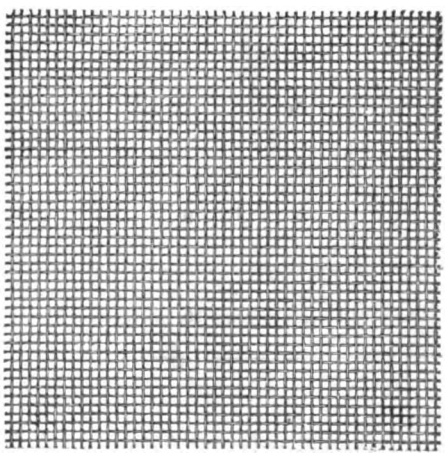
DIAGONAL SLOT



NEEDLE PUNCHED



HORIZONTAL SLOT



WIRE CLOTH

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BATTERY SCREENS

Battery screens are made of "needle" and "slot" punched Russia iron, with meshes ranging from No. 1 to No. 12 needle.

Also of steel and brass wire cloth, ranging from 12 to 80 meshes per inch.

The width of the slot in punched screens equals the diameter of the needle for like numbers on the list.

The table is so arranged that punched and wire screens of equal fineness occupy the same horizontal line.

Example—A No. 40 wire screen equals No. 9 slot or needle punched.

A wire screen having a corresponding mesh to a punched screen of the same area, has a greater discharging capacity, for the reason that it has a greater total area of openings than it is possible for the punched screen to have.

Price List of Perforated Screens. Price Cash. No. Discounts.				Steel Wire Cloth			Brass Wire Cloth		
No.	Equal to No. Wire Cloth.	Angle and Burred Slot.	Needle Punched.	Number of Mesh	Gauge of Wire	Price per Square Foot	Number of Mesh	Gauge of Iron	Price per Square Foot
		Per Sq. Ft.	Per Sq. Ft.						
3	15	60	75	12	23	60c	12	24	50
4	20	60	75	14	24	60	14	25	50
				16	25	60	16	26	50
5	25	60	75	20	26	60	20	27	50
6	30	60	75	24	27	60	24	30	50
7	35	60	75	.....	.....	.....	.....	.....	.....
8	40	65	80	30	29	60	30	31	52
				35	31	60	.....	.....	.....
9	45	70	1.00	40	32	65	40	33	55
10	50	75		.....	.....	.....	.....	.....	.....
11	55	85		50	35	75	50	35	58
				55	35	85	.....	.....	.....
12	60	95		60	36	95	60	36	60
				70	38	.....	70	37	70
Cast Steel Screens up to No. 10, 95c. per Sq. Ft.				80	40	.....	80	38	90

NOTE.—Needle punched, horizontal slot, at the same price.

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IMPROVED SECTIONAL CAST IRON APRONS AND SLUICES FOR GOLD MILLS.

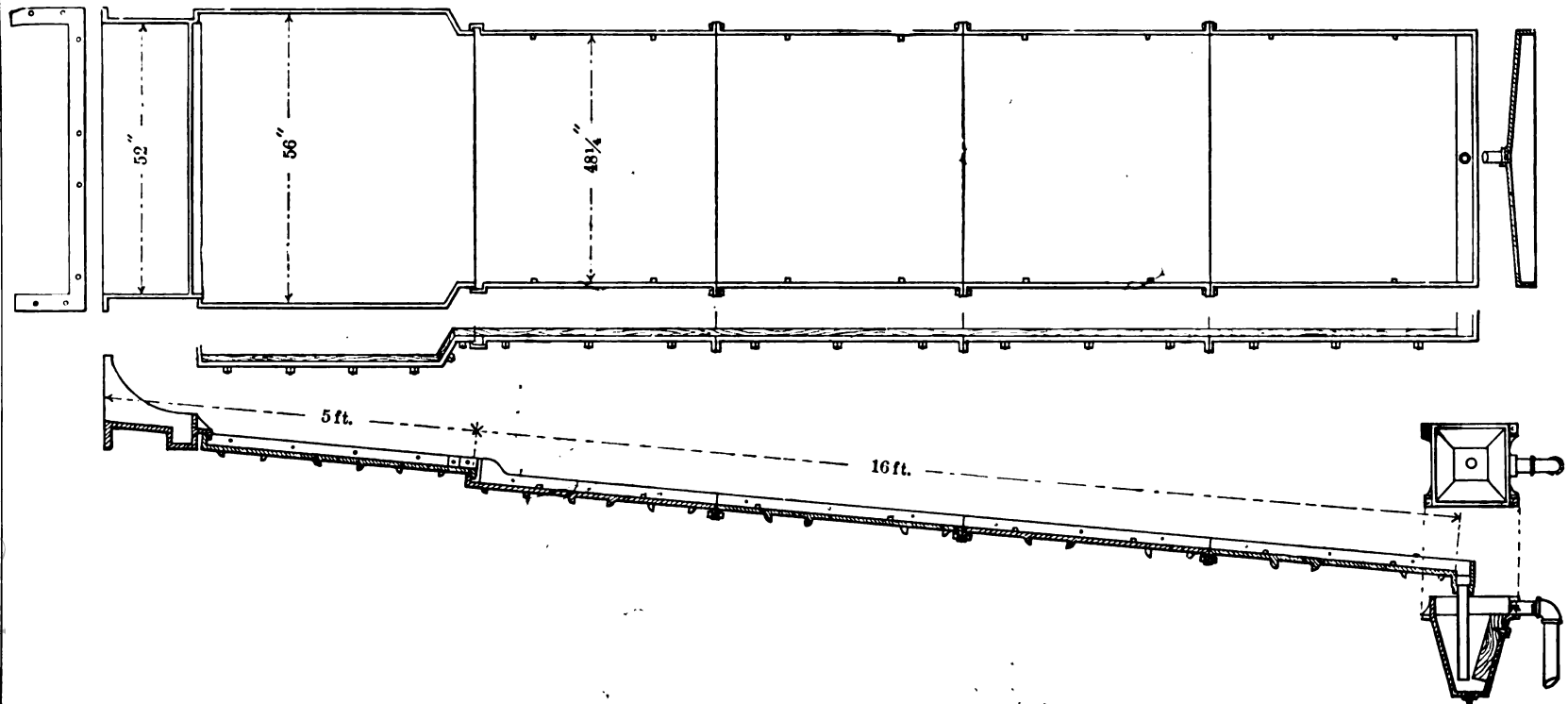


Plate 33.

Showing their connection with the Mortar Apron at the upper, and the Amalgam Trap at the lower end.
The sluices are made in four feet sections, any number of which can be used.

Weight of five feet apron " of sixteen feet sluice { 1,370 lbs. } Price, $

Distributing Box, weight, 189 lbs. Price, $

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WESTON'S
PATENT DIFFERENTIAL PULLEY BLOCKS

Number		Capacity, Tons	Will Hoist, Feet	Weight Complete, Pounds	Price
Direct blocks	1	¼	6	22	$13 00
" "	2	½	7	30	15 00
" "	3	1	8	51	20 00
" "	4	1½	8½	81	25 00
" "	5	2	9	122	30 00
Geared blocks	6	3	10	159	60 00
" "	7	4	11	257	80 00
" "	8	5	12	324	110 00
" "	9	6	13	493	150 00
" "	10	8	14	735	210 00
" "	11	10	16	1,054	275 00

Overhead travelers, sometimes called "crabs," "crawls," or "trolleys," used in connection with differential pulley blocks, are essential in every complete mill.

Iron mounted track timbers are provided and secured to the roof in such a manner as to traverse the entire length of the battery, pans, settlers, or other heavy parts of machinery requiring frequent handling, they are not only convenient, but save much time and labor.

OVERHEAD TRAVELERS

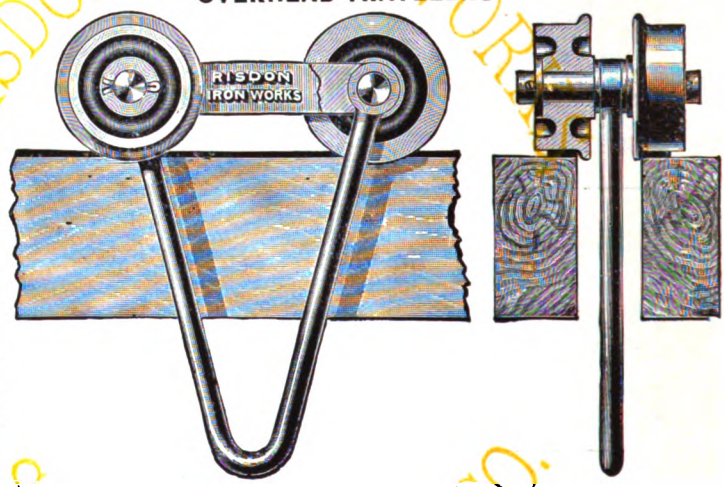


Plate 35

It is a good practice to have a hoist of this kind for each section of the mill. The small outlay will be fully repaid by the convenience they afford.

No. 35 is constructed chiefly of wrought iron.



Plate 37

No. 37 is made mostly of cast iron, and has the advantage of occupying less space below its track, affording more room for the hoist and load.

PRICE LIST

No.	Gauge of Track	Wheels		Weight	Price
		Face	Diam.		
35	6 in.	2 in.	8 in.	90 lbs.	$20
37	8 in.	2 in.	8 in.	175 "	25

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

RISDON IRON WORKS SAN FRANCISCO
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AMALGAM BARREL

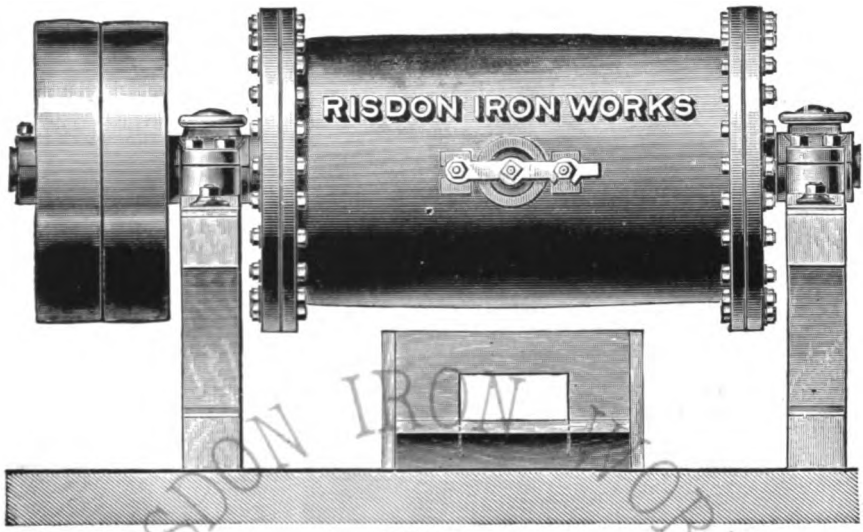


Plate 51

Crude amalgam, as collected from various parts of a mill, generally contains much foreign matter and various devices are employed to facilitate the "cleaning up" process. Plates No. 51 and No. 52 show an amalgam barrel used for this purpose. It is made of cast iron, cylindrical in form, and journalled at both ends. Suitable doors are provided as shown. Its dimensions are 24 inches inside diameter, 48 inches inside length, tight and loose pulley, each 36 inches diameter by 6 inches face.

No. 1, shipping weight, 2600 pounds. **Price, $**
No. 2, " " 1600 " "

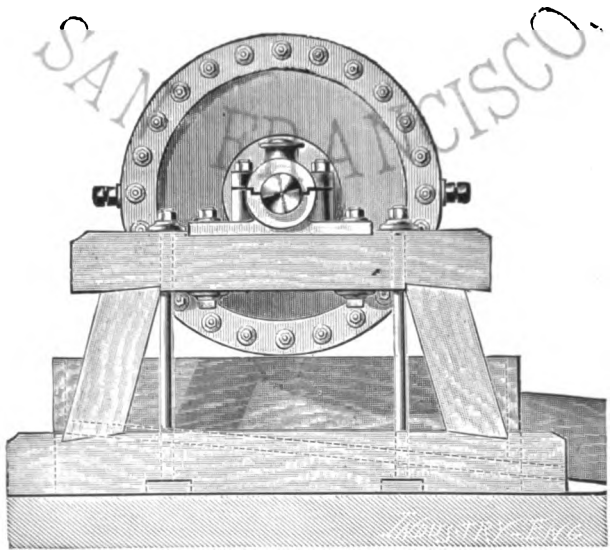


Plate 52

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CLEAN UP PAN

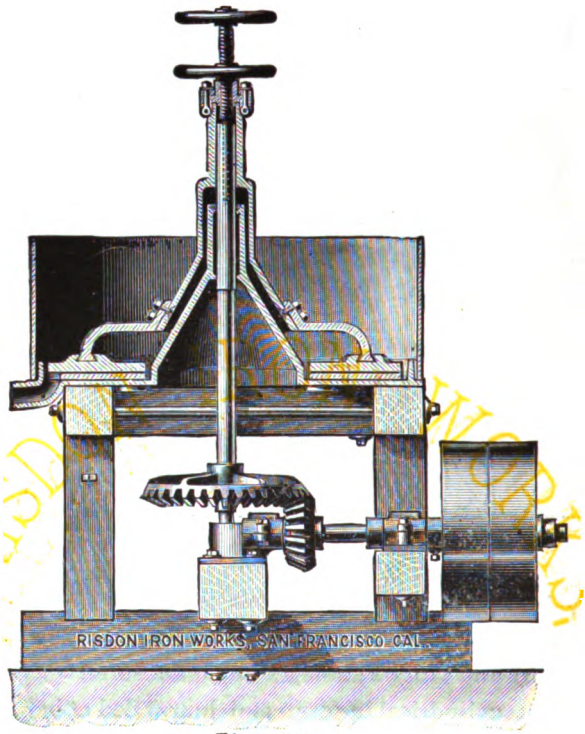


Plate 53

No. 53 shows a Clean-Up Pan used to cleanse the amalgam which has been gathered from the mortars and amalgamating plates, and which always contains more or less foreign matter. These impurities are washed off, and the amalgam worked to a uniform consistency before straining the surplus quicksilver from it, to prepare the amalgam for the retort. Adjustable wooden shoes are secured to the arms, which very much resemble settler arms in form.

The hand wheels and screws are used to raise and lower the shoes and driver as may be required.

Their speed is usually from 20 to 40 revolutions (according to diameter of pan), and require very little power.

They are frequently converted into sampling and grinding pans for testing and working small quantities of various ores, tailings, slimes or sulphurets.

Iron shoes are sometimes substituted for wood when grinding.

TABLE OF OUR STANDARD SIZES

No.	Diameter Pan	Dimensions of Pulleys	Weight	Price
1	18 in.	18″x6″	425 lbs	$ 75 00
2	24 "	20″x6″	700 "	100 00
3	36 "	24″x6″	1150 "	135 00
4	48 "	24″x6″	1450 "	150 00
5	60 "	30″x6″	2400 "	200 00

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CYLINDER RETORT

No. 65 shows the smaller pattern of cylinder retorts and melting furnaces combined in one setting, such as are used in large gold mills and small silver mills.

After being thoroughly strained, the amalgam is placed in the retort, in suitable iron pans; the retort is then sealed, except the vapor discharge pipe, the open end of which is placed under water in the condenser tank. A water jacket condenser is fixed to and surrounds the vapor pipe, through which a continual supply of cold water flows, condensing the vaporized quicksilver while passing through it to the settling tank.

The time required to retort a charge of amalgam depends largely upon circumstances, and varies from one to four hours.

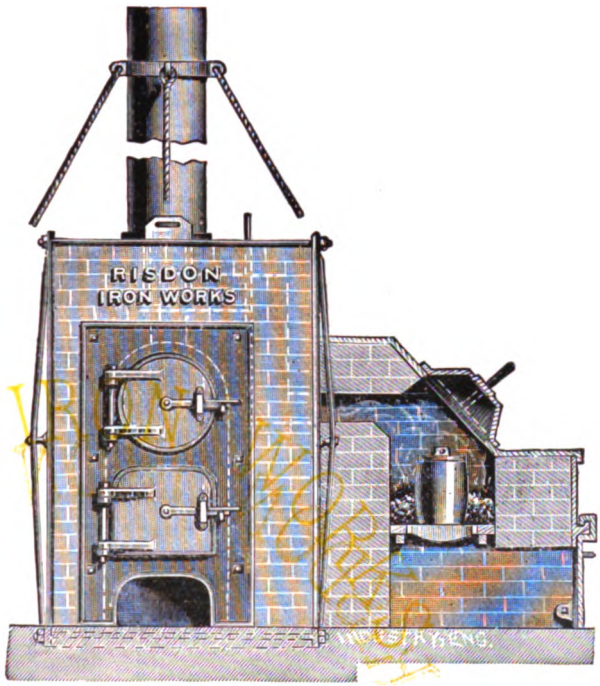


Plate 65. Front View

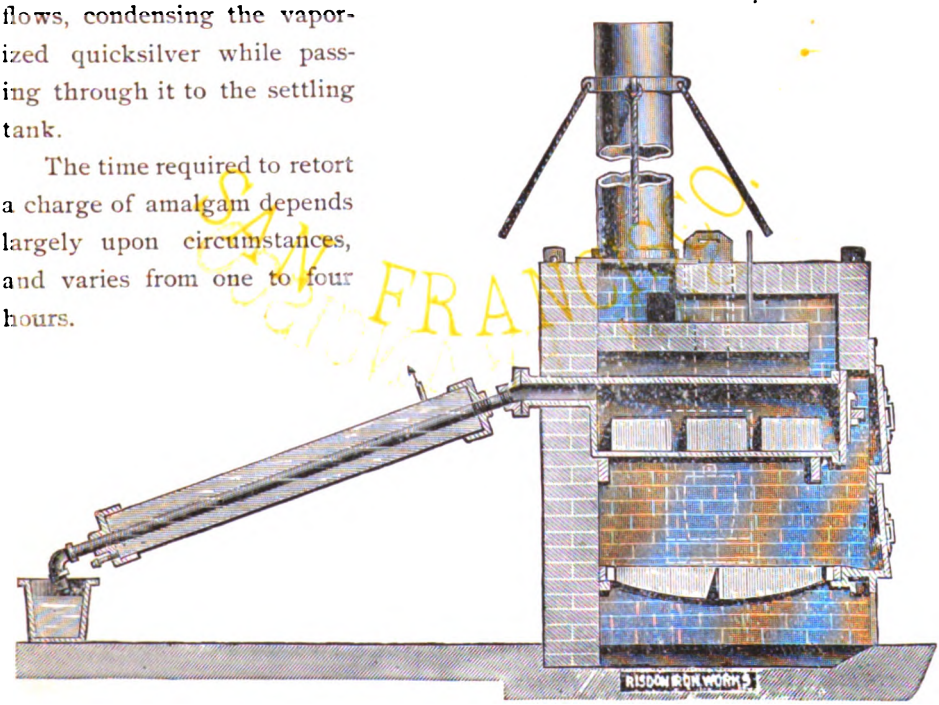


Plate 65. Longitudinal Section

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RETORTS and MELTING FURNACES



Plate 63

Pot Retort

Various styles and sizes of retorts are used. Gold mills require much less retorting capacity than silver mills of the same crushing capacity.

Many small gold mills use the simple "pot" retort (shown in plate No. 63), which is portable, and can be used on an ordinary forge, or in a temporary furnace prepared for the occasion.

It is more economical and satisfactory to have all retorts placed in permanent settings.

POT RETORT

Table of Sizes and Price List

No.	Capacity in Pints	Capacity in Lbs. Amalgam	Weight in Lbs.	Price
1	1	12	10	$4 50
2	2	24	14	5 50
3	3	36	17	7 00
4	4	48	24	8 00
5	5	60	30	9 00
6	6	72	45	10 50
7	10	120	65	12 00

CYLINDER RETORTS

STANDARD SIZES

Trade No.	Retort		Smoke Stack		Total Weight, Retort and Fittings	Price
	Diam. Ins.	Length Ins.	Diam. Ins.	Length Ft.		
1	9½	30	10	20	1100 lbs.	
2	10	24	10	20	800 "	
3	10	30	10	24	1327 "	
4	10	36	10	24	1300 "	
5	12	48	12	24	2500 "	
6	14	60	14	24	3900 "	

MELTING FURNACE IRONS

Figure 67

Style of Furnace	Double Doors		Grate Bars		Weight	Price
	Width	Length	No.	Length		
Same as in cut	12	24	12	18	140 lbs.	$15 00
" "	12	24	18	18	300 "	20 00
" "	12	24	24	18	410 "	25 00
United States Mint Pattern	14	14	13	15	1080 "	75 00

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IMPROVED CYLINDER RETORT

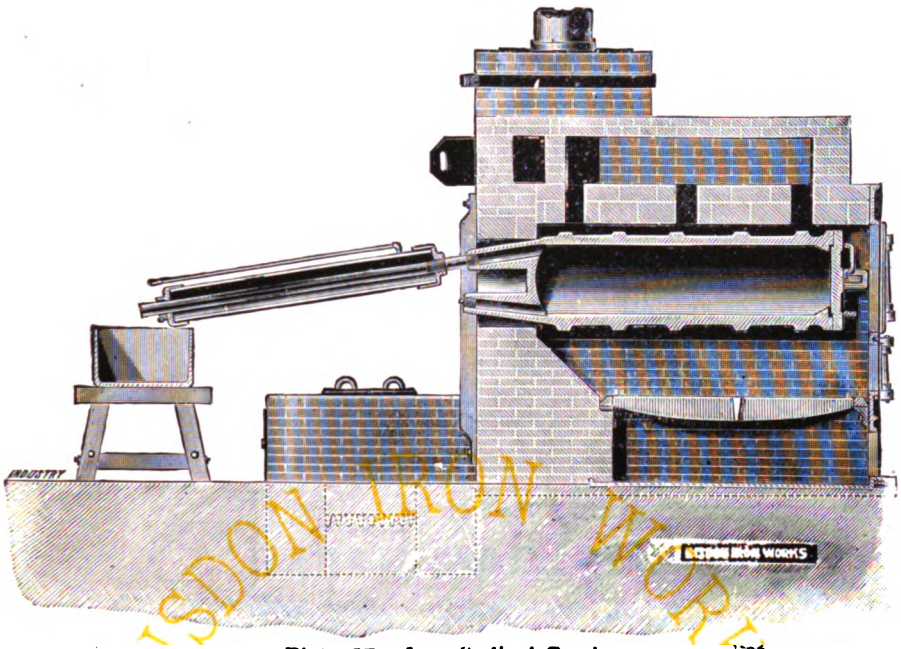


Plate 67. Longitudinal Section

No. 67 is our standard 14 x 60 "silver" retort, embodying Mr. Boss's improvements, by which the usual objectionable bearing bars are entirely dispensed with, the retort having a series of brackets cast on its sides, which rest on the brick walls, exposing the entire lower surface of the retort to the fire, insuring a uniform distribution of heat to all parts of the retort.

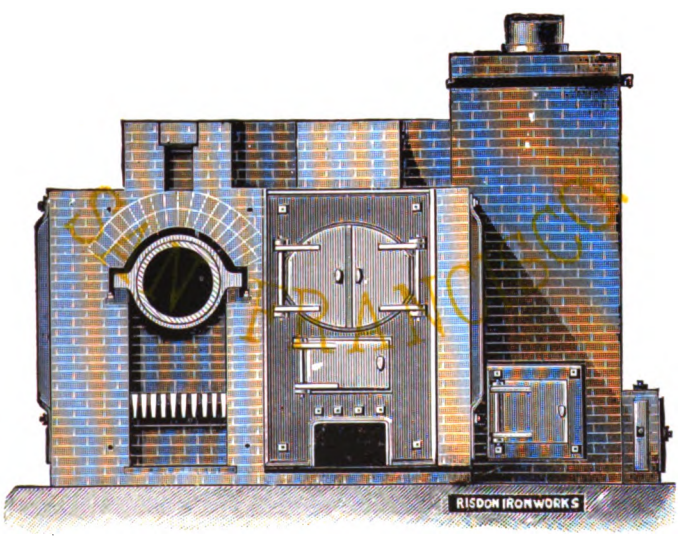


Plate 67. Front View

The band ribs which surround the retort prevent "warping."

Its supporting brackets are placed centrally so as to admit of turning the retort over and using both sides, thus increasing its life materially.

We manufacture the ordinary melting furnace irons, and the United States Mint pattern; also the well known Boss Melting Furnace.

We append tables of sizes and price lists of retorts and furnaces.

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QUICKSILVER AND AMALGAM TRAP FOR GOLD MILL

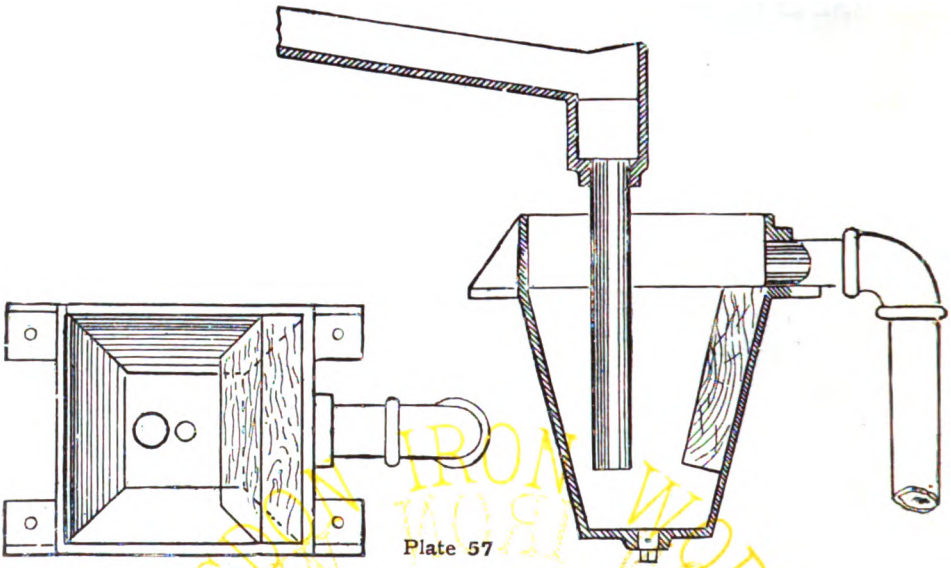


Plate 57

AMALGAM SAFES

No. 61 is a cylindrical iron amalgam safe, provided with a hinged cover, which is secured with a padlock, as shown. A conical canvas amalgam strainer is suspended immediately under the cover, within the safe, which receives the amalgam as it is drawn from the pans and settlers.

As quicksilver largely predominates in this amalgam, it is necessary to strain off as much of it as will filter by its gravity through the canvas, to better prepare it for the retort. Considerable time is required to strain thoroughly. The operation requires no attention, and is usually conducted under lock and key. The strained quicksilver flows into the receiver, from whence it is elevated for redistribution.



Plate 61



Plate 59

No. 59 is a somewhat similar safe, constructed simpler and cheaper.

No. 61. Weight, lbs., price, $
No. 59. " " " $

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BELT TIGHTENER

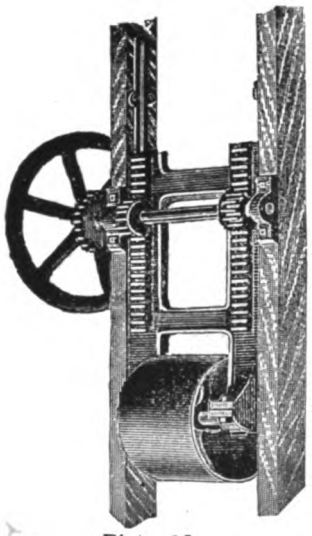


Plate 41

Plate No. 41 shows an ordinary tightening pulley and frame, with dimensions and price list. These prices include all the iron work, but not the wood. Special sizes furnished when required.

PRICE LIST

No.	Length of Adjustment, feet	Size of Pulley Diameter Face	Diameter of Shaft	PRICE
00	1½	12x 9	1¾	$ 30 00
0	1⅔	18x12	1¾	40 00
1	2	24x14	2	50 00
2	3½	28x20	2½	65 00
3	4	30x26	2¾	120 00
4	5	42x38	3	250 00

BATEA FOR GOLD MILL

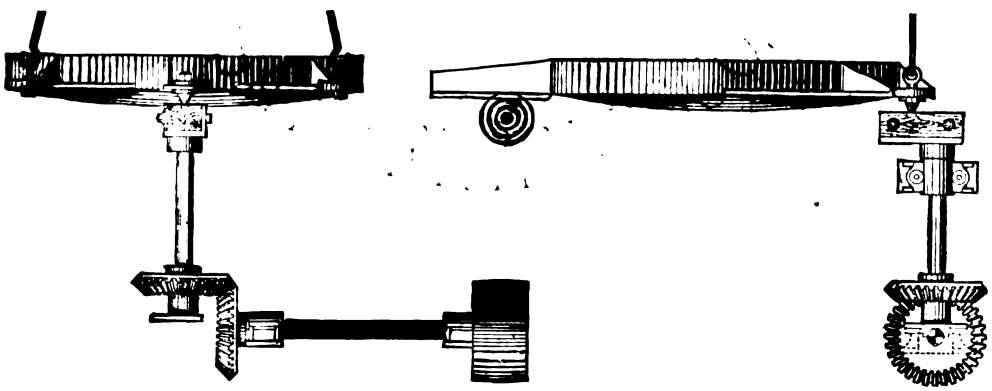


Plate 55

Plate 55 shows a Batea which is sometimes used for the same purpose. It is made in the shape of a pan, suspended at one side by two rods and at the other side is supported by a roller. A vertical crank shaft is attached to the suspended side by a suitable crank pin, giving the pan that peculiar motion from which it has obtained its name.

No. 1 is 41 inches diameter, weight 640 pounds, price, $.
" 2 is 48 " " 775 " "

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Free Gold Prospecting Mill

Consisting of a THREE-STAMP BATTERY Complete with all Framework and Power by

Risdon Iron Works, San Francisco, Cal.

This illustration shows our Three-Stamp Portable Mill, used largely for prospecting: the total weight is about 4,000 lbs. The following description and specification will give all the information as to what is included :

STAMPS.

1 3-Stamp Mill, 250 lbs. each stamp, of improved design, arranged to be operated in one battery by belt from stamp countershaft, including frame work, bolts, iron work and pipe complete.
1 High Mortar or Battery, weight about 1,000 lbs., bottom and screen frame seats planed. Holes arranged for receiving copper lining, front and back.
1 Wood screen frame fitted to mortar.
2 Wrought iron keys for holding screen frame in place.
1 Russia iron screen of necessary dimensions.
3 Cast iron Stamp Shoes.
3 Dies made of cast iron.
3 Cast iron heads, bored for stem and recessed for shoe stem.
3 Stems of best refined iron, with both ends tapered and fitted to head ; ends being tapered, should one end break, the stem can be reversed and other end used.
3 Tappets, cast iron, with wrought iron gibs and steel keys, all fitted to place.
3 Double Cams, cast iron, bored and fitted to cam shaft with steel keys, all properly marked to place to give proper drop.
1 Heavy hammered iron Cam Shaft, turned full length and keyseated for pulley and cams.
2 Wrought iron Collars with steel Set Screws, fitted to cam shaft.
2 Heavy Corner Cam Shaft Boxes, babbitted and bored, planed upon bottom and furnished with bolts and caps.
1 Jack Shaft.
2 Jack Shaft Boxes.
3 Iron Sockets for wood levers, lined with leather.
3 Wood levers or Finger Pieces for holding up stamps, fitted to sockets.
1 Complete set of wood guides properly fitted to stems, with all bolts, nuts and washers.
1 Sheet of ⅛″ Rubber for mortar to rest upon.
All Bolts, Rods, Nuts and Washers for 3-stamp frame work, complete, including all holding down bolts and washers for mortars.
1 Battery frame complete, with Table for Copper Plate to rest upon.

WATER PIPES.

1 Complete set of Water Pipes for 3 Stamps proper, with valves and fittings ready for connection with main supply pipe, also rubber hose for washing copper plates in front of mill.

COPPER PLATES.

1 Copper Plate 48″x23¼″x⅛″.
1 Copper Plate 21½″x8″x3-16″.
1 Copper Plate 21½″x4″x3-16″.
All the above Copper to be of the best quality Lake Superior, without flaws.

SHAFTING, PULLEYS AND BELTING.

1 Battery Countershaft, 2″ Ga. dia. x 30″, with all boxes, bolts, etc., for receiving belt from engine.
1 30″x6½″ Pulley for receiving belt from engine.
1 Pulley 18″x7″ to drive cam shaft.
1 Cam Shaft Pulley, 36″x7″.
24 Feet of 6″x4-ply Belting to drive cam shaft.
50 Feet of 6″x4-ply Belting to drive battery shaft from engine pulley.

In ordering state the following particulars:

1. Mill complete with frame. 2. Silver Plate, Copper Plate. 3. Steam or Water Power. 4. Johnston Concentrator.

If water power, state head. If automatic feeder or rockbreaker is required or if you wish to run pump, state size.

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RISDON IRON WORKS FRICTION CLUTCH PULLEY

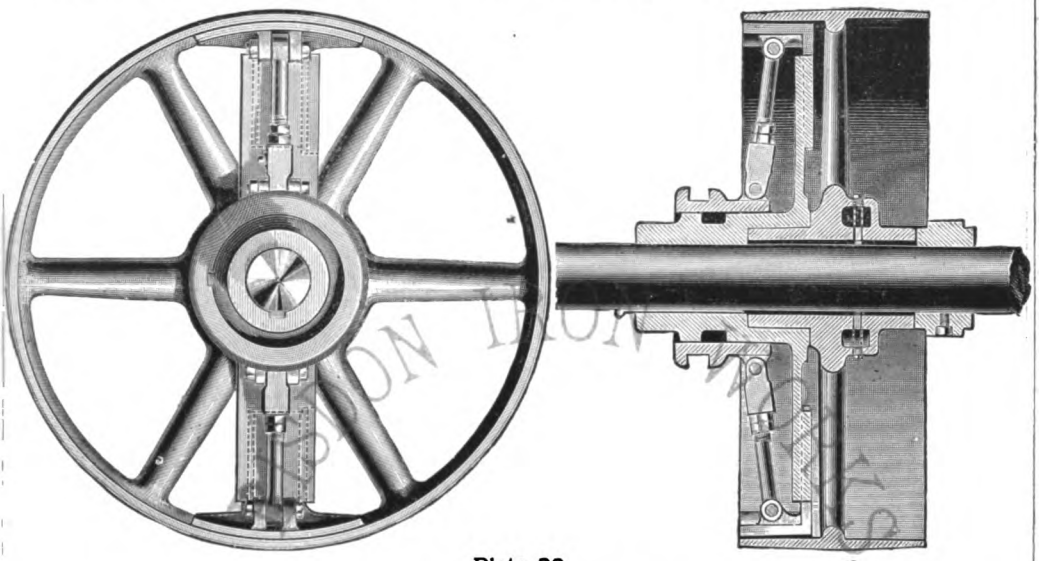


Plate 39

Plate No. 39 is an improved friction clutch pulley used in gold and silver mills for the purpose of engaging and releasing any section of the machinery requiring occasional stops, without checking the speed of the mill. Such arrangements are necessary in large mills. They prevent much delay and annoyance, and permit the repairs of any section of the mill without stopping the other parts.

Plate 40 is another form of pulley used for the same purpose, and known as the "Hill Clutch Pulley." This clutch engages the pulley at four points, while No. 39 engages it only at two points. Both are reliable pulleys, and are used for a variety of purposes.

HILL DOUBLE ARM CLUTCH PULLEY

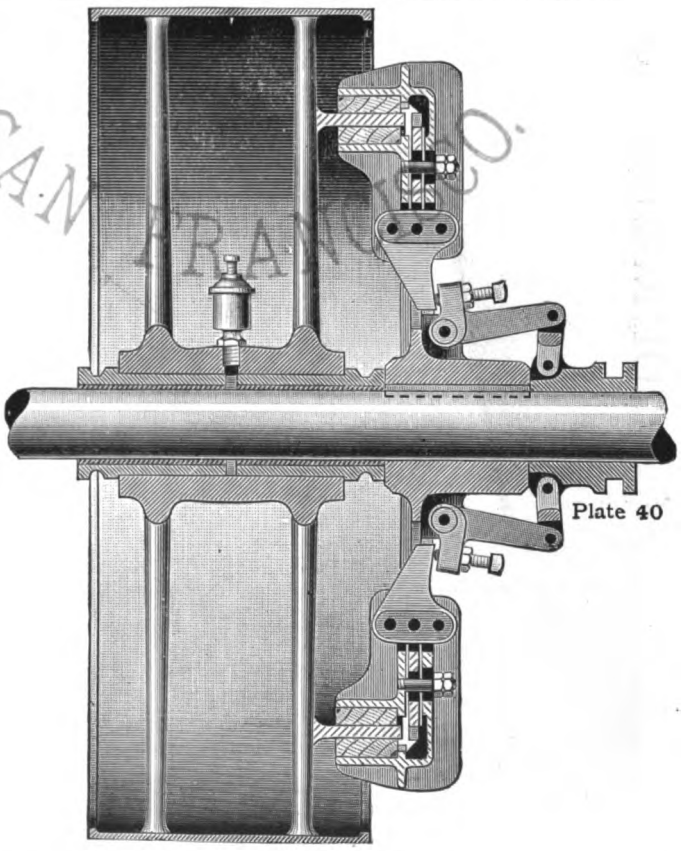
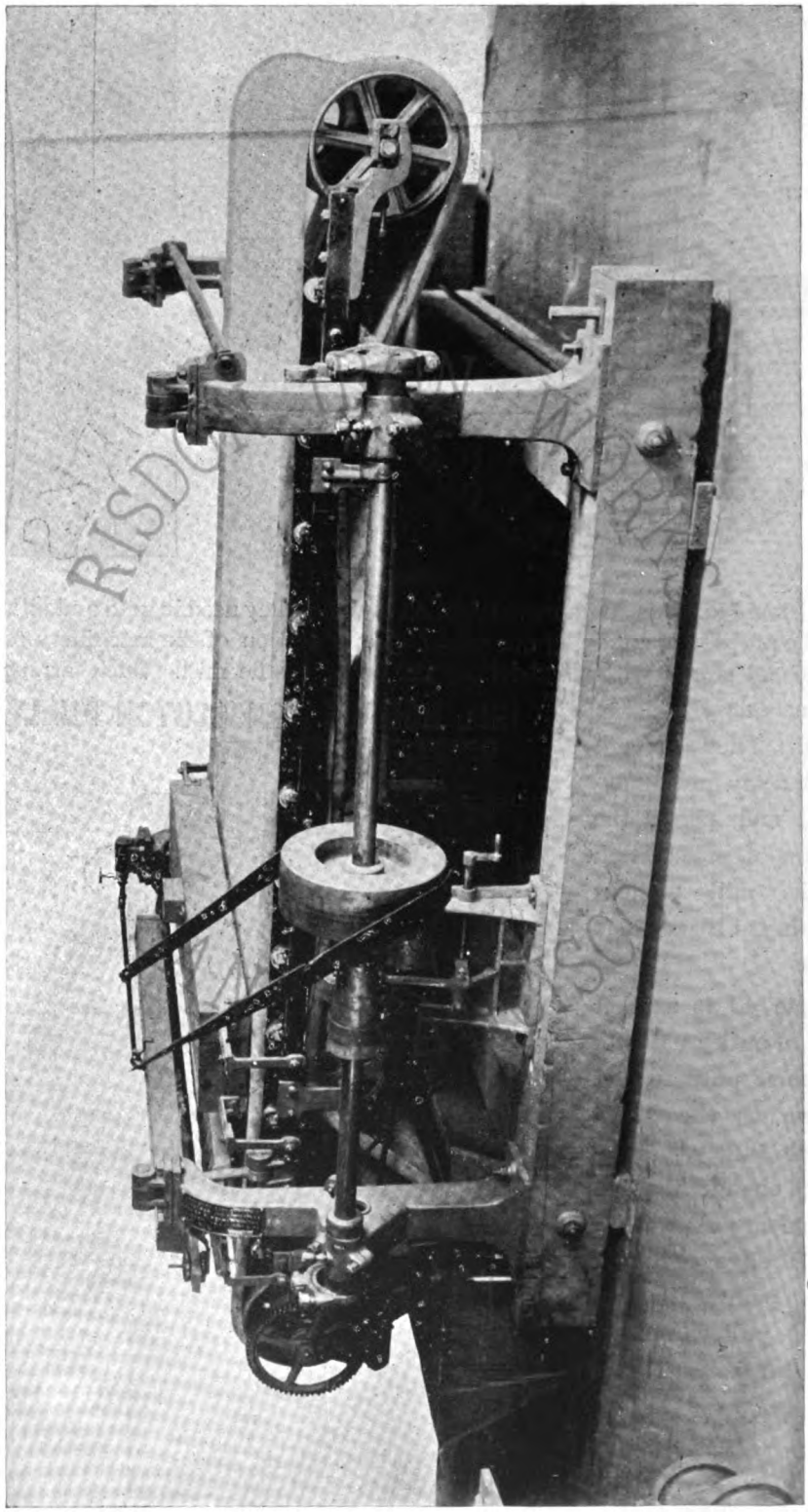


Plate 40

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JOHNSTON CONCENTRATOR.

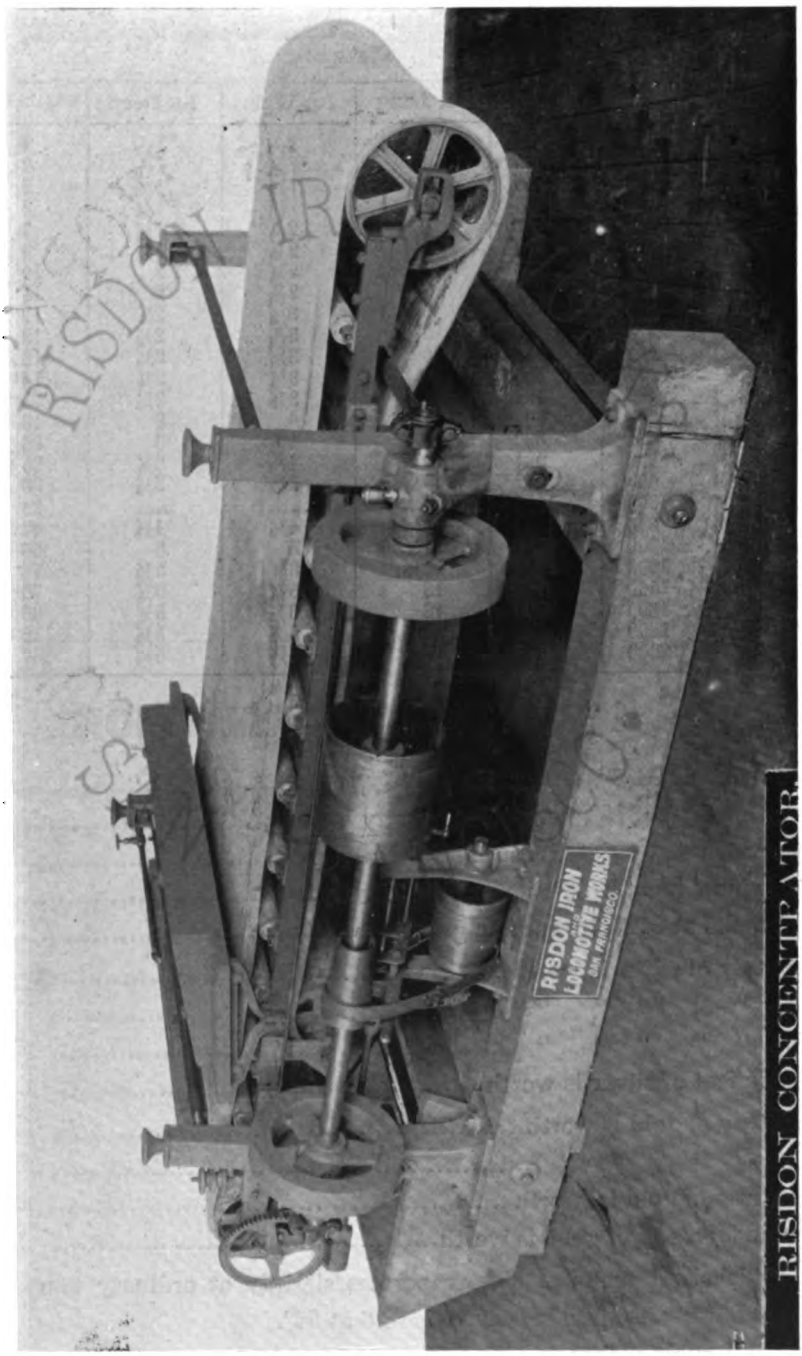


SEND FOR SPECIAL CATALOGUE.

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Risdon Concentrator, Risdon Iron Works.

"Frue Type"



SEND FOR SPECIAL CATALOGUE.

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INGOT MOLDS

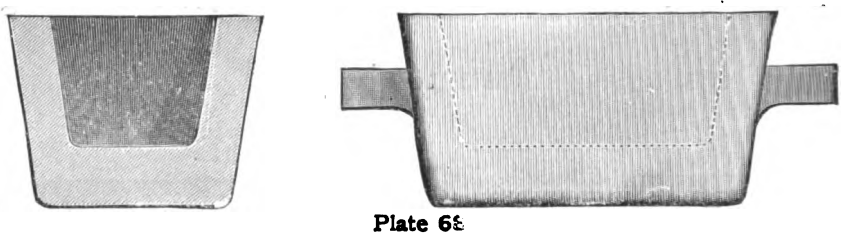


Plate 65

Trade No.	Oz. Silver	Oz. Gold	In. Long	In. Wide	In. Deep	Weight Lbs.	Each
1	15	28	2½	1 7/16	1 1/16	1	$0 35
2	20	35	3	1 5/8	1 3/8	2	40
3	27	50	3 9/16	1 11/16	1 5/8	3	50
4	40	75	4 1/8	1 11/16	1 1/2	5	60
5	52	107	4 1/16	2 1/16	1 1/2	7	75
6	80	150	4 11/16	2½	1¾	9	1 00
7	107	200	5	2¾	2	10	1 25
8	112	207	5 9/16	2 9/16	2	11	1 50
9	160	300	5¾	3 1/8	2¼	12	2 25
10	200	.....	6¾	3 5/16	2 3/8	13	2 50
11	210	388	6¾	3 1/8	2½	13	2 75
12	250	400	6 7/8	3¼	2¾	14	3 00
13	265	495	7 1/8	3½	2 7/8	15	3 00
14	320	600	7¼	4	3	19	3 25
15	428	800	8¾	4 1/16	3	28	3 50
16	500	921	9½	4 3/16	3¼	35	3 75
17	600	.....	10¼	4 5/8	3½	36	4 50
18	683	1000	.....	.....	.....	38	4 50
19	810	1500	11⅛	4 7/8	4⅛	42	5 50
20	1000	1840	11¼	5	5	50	6 00
21	1200	2208	12½	5¼	5⅛	72	7 50
22	1500	2760	13	5¾	5¼	76	10 00
23	1600	2800	13	6½	5¼	85	11 00
24	1800	.....	13½	6½	5½	110	12 00
25	2000	3680	15	6½	5½	147	13 50

USEFUL INFORMATION

Gold melts at 2016°, its specific gravity is..... 19.3

Silver melts at 1873°, its specific gravity is..... 10.5

Copper melts at 1996°, its specific gravity is..... 8.9

Cast iron melts at 2786°, its specific gravity is..... 7.8

Lead melts at 612°, its specific gravity is..... 11.3

1 oz. troy of silver is worth.....	$ 1.2929
1 lb. " " " " "	18.854
1 ton " " " " "	37,709.50
1 cubic foot of silver is worth.....	12,355.20
1 oz. troy of gold is worth.....	20.6717
1 lb. " " " " "	301.46
1 ton troy of gold is worth	602 927.36
1 cubic foot troy of gold is worth.....	361,808.64

Quicksilver melts at 39°, evaporates slightly at ordinary temperature, and boils at 662°. Its specific gravity is 13.6 at 32°.

2.038 cubic inches weighs 1 lb.

One cubic foot weighs 847.89 lbs.

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POWER REQUIRED

FOR

DIFFERENT PARTS OF GOLD AND SILVER MILLS

Each 850 lb stamp, dropping 95 times per minute, requires 1.33 horse-power.
" 750 " " 95 " " " 1.18 "
" 650 " " 95 " " " 1.00 "
" 13 in. by 18 in. Blake Rock Breaker, requires 20 horse-power.
" 9 in. by 15 in. " " " " 9 "
" 8 in. by 10 in. " " " " 6 "
" 8 in. by 12 in. Dodge " " " 7 "
" 7 in. by 8 in. " " " " 5 "
" 6 in. by 6 in. " " " " 3 "
" Frue or Triumph Concentrator, 220 rev. per minute, requires 1 horse-power.
" 48 in. clean up pan, making 30 rev. " " 1.5 "
" amalgam barrel, " 30 " " " 2.5 "
" Batea at usual speed, requires 1 horse-power.
" 5 ft. combination pan, making 65 rev. per minute, requires 5 to 10 h. p.
" 4 " " " 65 " " " 3 to 6 "
" 8 ft. Settler, making 14 rev. per minute, requires 2.5 horse-power.
" 8 ft. Agitator, " 16 " " " 3 "
" quicksilver elevator requires .25 to 2 horse-power.
" revolving dryer requires 3 horse-power.
" Howell-White roasting furnace requires 4 to 6 horse-power.
" Thompson " " " 1 to 3 "
" Bruckner furnace, 8 ft. by 18 ft., requires 5 to 8 "
" set high speed crushing rolls requires 10 to 50 "
" ore sampler and grinder requires 3 horse-power.

The above estimates include the friction of the parts named, but not that of the power-transmitting machinery, for which an additional allowance should be made.

WATER REQUIRED

FOR

VARIOUS PARTS OF GOLD AND SILVER MILLS

Boiler feed water for each horse-power per hour, 5 gallons.
For each stamp, per hour, 60 to 80 gallons.
" 5-ft. pan, " 100 gallons.
" 8-foot settler, 80 gallons.
" concentrator, per hour, 200 to 300 gallons.

When water is settled and returned to the mill for re-use, a reduction of 50 per cent may be safely estimated for all except the boiler, which must have clear water.

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CHLORINATION MILL

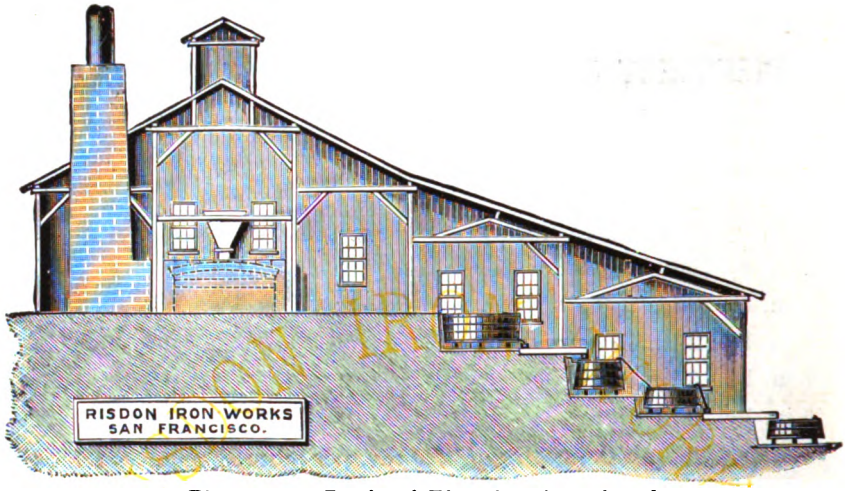


Plate 137. Sectional Elevation through *a b*

When concentrators or vanners are used in gold mills, their product is known as "concentrates" or "sulphurets." These contain the residue of the precious metals that has escaped amalgamation in the battery and on the "plates."

It has been stated elsewhere that the value of a ton of these concentrates is usually many times greater than the original value of a ton of the ore from which they have been extracted. And it is for the purpose of extracting this value from the concentrates that the chlorination mill is used.

Assuming that the ore from which the concentrates came, contained 2½ per cent of sulphurets, then 2½ tons would represent the product of a 100-ton mill, if 5 per cent a 50-ton, and if 10 per cent a 25-ton mill.

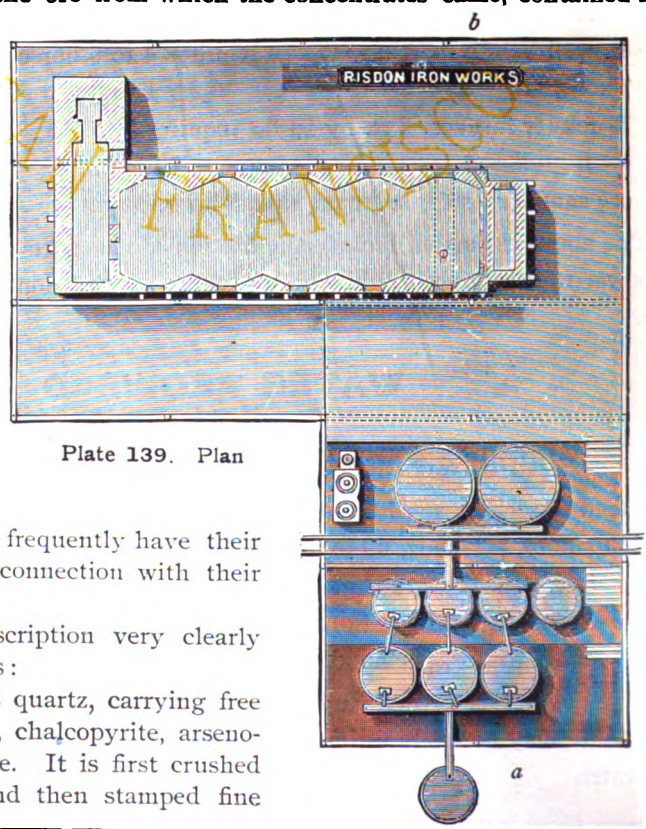


Plate 139. Plan

The cost of treating concentrates in these mills ranges from $8 to $15 per ton.

Large gold mines frequently have their chlorination mill in connection with their stamp mill.

The following description very clearly illustrates this process:

The ore treated is quartz, carrying free gold, pyrites, galena, chalcopyrite, arsenopyrite and zinc blende. It is first crushed in rock breakers, and then stamped fine

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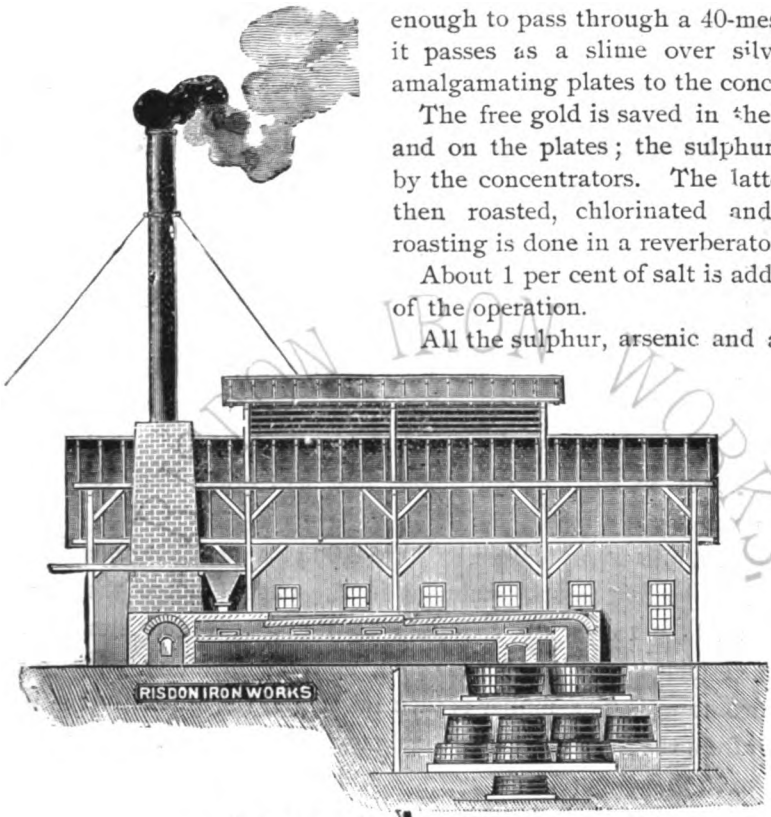


Plate 141. Section through *c d*

enough to pass through a 40-mesh screen. Then it passes as a slime over silver-plated copper amalgamating plates to the concentrators.

The free gold is saved in the stamp batteries and on the plates; the sulphurets are collected by the concentrators. The latter are dried and then roasted, chlorinated and leached. The roasting is done in a reverberatory furnace.

About 1 per cent of salt is added near the close of the operation.

All the sulphur, arsenic and antimony are expelled, and the iron and other base metals oxidized. The gold is left in a free metallic state, the silver being partly concentrated into a chloride by the salt.

The roasted ore is then transferred to chlorinating tanks, each holding from two to three tons. The covers are put on, and the joints calked with rags and luted with dough, to make it gas tight. The tanks have false bottoms, perforated with holes of suitable size and covered with sacking.

Chlorine gas, made from salt, black oxide of manganese and sulphuric acid, is then introduced below the false bottom and allowed to permeate the ore. Two or three days are required for their permeation. The gold and silver is thus concentrated into chlorides.

The chloride of gold is leached out by water added at the top, and drawn off at the bottom and run into precipitating tanks. The gold is precipitated in a fine metallic state, by the addition of the sulphate of iron. The water is then run off, the gold collected and dried, melted in graphite crucibles and cast into bars.

The silver chloride remaining in the ore is dissolved out by a solution of hyposulphite of calcium. The solution is run into other tanks, and the silver precipitated as a sulphide by adding calcium of polysulphide.

The sulphide of silver is dried, roasted and then melted and cast into bars.

The accompanying illustrations, plates Nos. 137, 139 and 141, represent a mill of 2½ to 3 tons daily capacity.

Iron required for furnaces	8,000 lbs.
Bricks " "	50,000
Number of chlorinating tanks	2
" leaching "	4
" precipitating "	3
" of chlorine generators	1
Price of iron and woodwork	$

We furnish chlorinating mills of any desired capacity.

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WET CRUSHING SILVER MILL

Free milling silver ores pass through the same process as gold ores, until the battery is reached. Then the amalgamating plates of the gold mill are omitted, and the pulp flows from the batteries in sluice boxes to the settling tanks, usually arranged in rows between the batteries and pans.

Various sizes and patterns of pans are used for grinding and amalgamating, usually one 5-foot pan for two stamps. These pans are arranged in a row, allowing a narrow platform between them and the settling tanks. The settlers are located immediately in front of and about four feet lower than the pans; one settler to two pans.

The capacity of a 5-foot pan is from 2,000 to 3,000 lbs. per charge, and each charge requires four to five hours treatment in the pans. When the pan is charged, water is added to reduce the pulp to the proper consistency, the chemicals are then added, the muller lowered, and the grinding takes place during the first two hours. The muller is then raised and the quicksilver added, changing the pan from the grinding to the amalgamating period. Amalgamation then continues two to three hours.

The pans are usually provided with steam chambers, where either live or exhaust steam is used to heat the charge to the proper temperature, which must not be so great as to vaporize the quicksilver.

When the time to draw off the amalgamated pan charge arrives, an empty settler is ready to receive it. The charge flows into the settler, which is much larger than the pan. Enough cold water is added to fill the settler, thus reducing and cooling the thick hot pulp to the condition best adapted to settling. The speed of the settler is so regulated that the pulp is barely held in suspense, while the greater specific gravity of the amalgam causes it to settle to the bottom, where it remains until drawn off at the pleasure of the amalgamator. The settling of a charge is accomplished in half the time it requires in the pan, consequently one settler serves for two pans. After settling is complete, the charge is drawn off at the series of discharge nozzles, commencing at the upper one and continuing downward as the charge recedes, always leaving the portion containing the amalgam in the settler. The amalgam is then strained, the quicksilver is elevated to the pans, and the amalgam retorted.

The water flowing from the settling tanks frequently carries slimes with it, which are often valuable. In which case they are settled in reservoirs, dried and amalgamated separately.

See plate 75.

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60-STAMP WET CRUSHING SILVER MILL.

TANK SYSTEM.

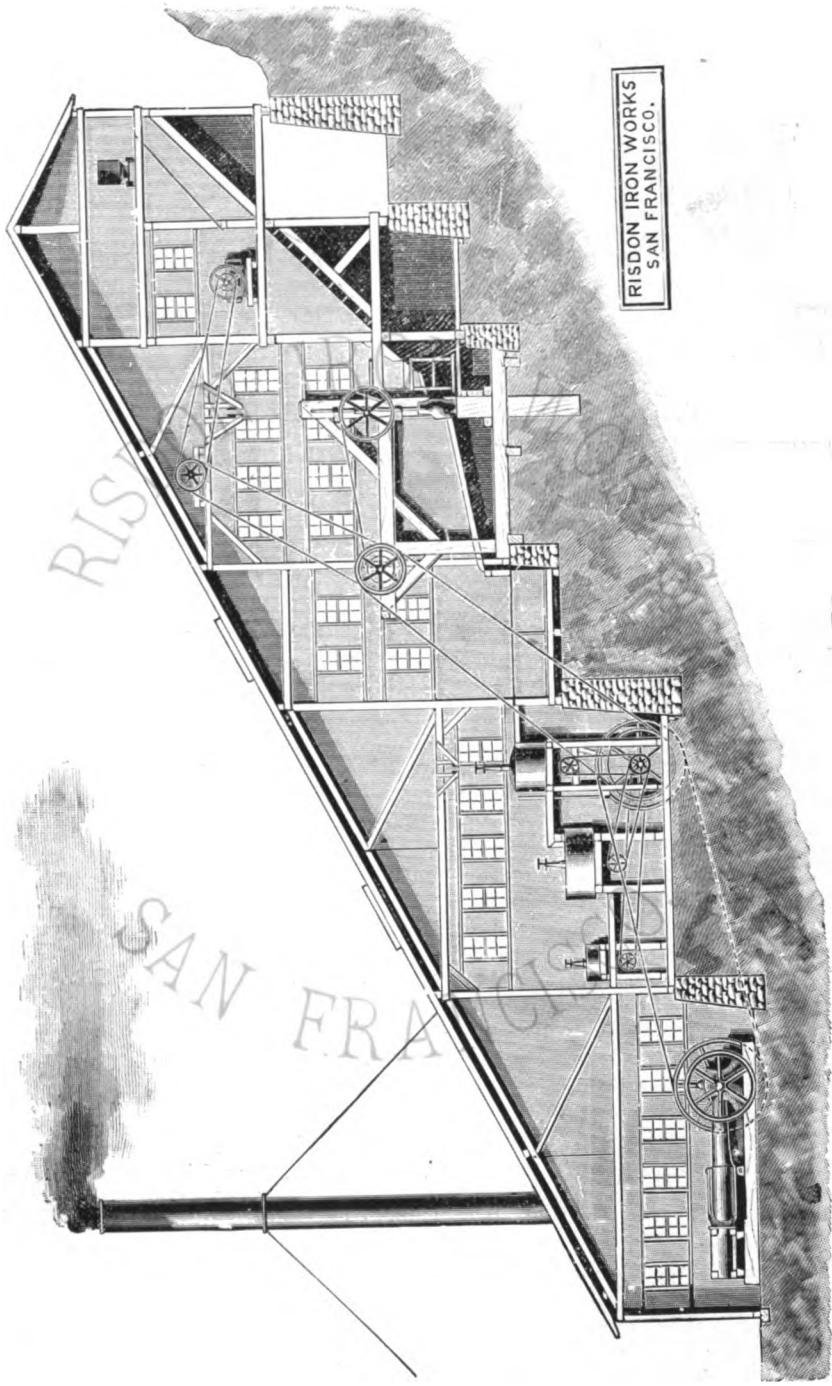


Plate 75.

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COMBINATION PAN

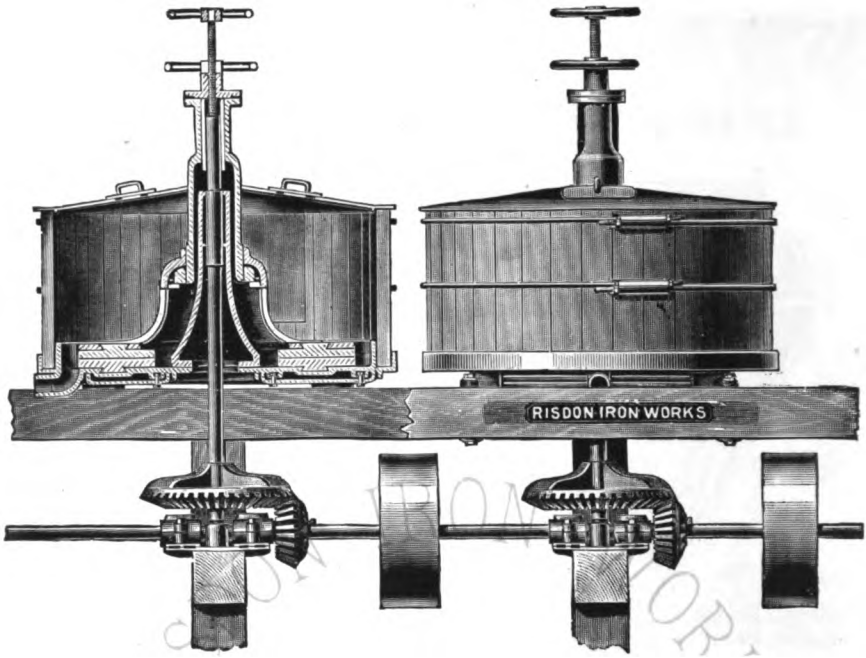


Plate 77

Is a 5-foot combination pan in section and elevation. This pan is a combination pan in fact as well as in name, and owes its name to the circumstances attending its production. The first is that it is both a grinding and amalgamating pan; the second, that its construction combines the most valuable features of the various amalgamating pans that immediately preceded it.

The most prominent of those were the "Knox," the "Hepburn," the "Wheeler," the "Horn" and the "Greeley" pans. All of these pans had good points, and all of them had objectionable features, and it was at this time that the active development of the amalgamating pan was going on. Many of the best metallurgists and mill men were working hard to perfect them.

The combination pan is the result, and may properly be called a compromise pan, and is to-day the standard grinding and amalgamating pan used in wet silver mills with the tank system of amalgamation.

They usually have wooden sides, but may be made of iron.

A steam chamber is provided in the bottom, in which either exhaust or live steam is used to heat the pulp in the pan to the required temperature.

The shoes and dies are usually made of hard iron, and are secured to the muller and pan bottom by suitable dovetailed lugs, having a corresponding recess in the muller and pan bottom.

The cone is cast separately and bolted to the bottom.

The driver is made in two sections. The joint by which they are connected permits an automatic adjustment of the shoe surface to the face of the dies.

The muller and driver have the usual hand-wheel adjustment for raising and lowering the muller.

The spaces between the shoes on the muller, and between the dies on the pan bottom, represent curved radial lines, and are so arranged that a continual current of pulp flows through them for the purpose of giving better circulation to the pulp. This circulation is desirable for the purpose of presenting all particles of ore to the grinding surfaces in turn, as well as to assist amalgamation.

Although the plate shows these pans driven by belt and gear wheels, they may be driven with friction wheels. The depth of these pans is often increased to 36 inches.

Speed of 5-foot pans from 65 to 75 revolutions.
Weight of pans, 6500 lbs. Price, complete, $.

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20-STAMP WET CRUSHING SILVER MILL.

BOSS CONTINUOUS SYSTEM OF AMALGAMATION.

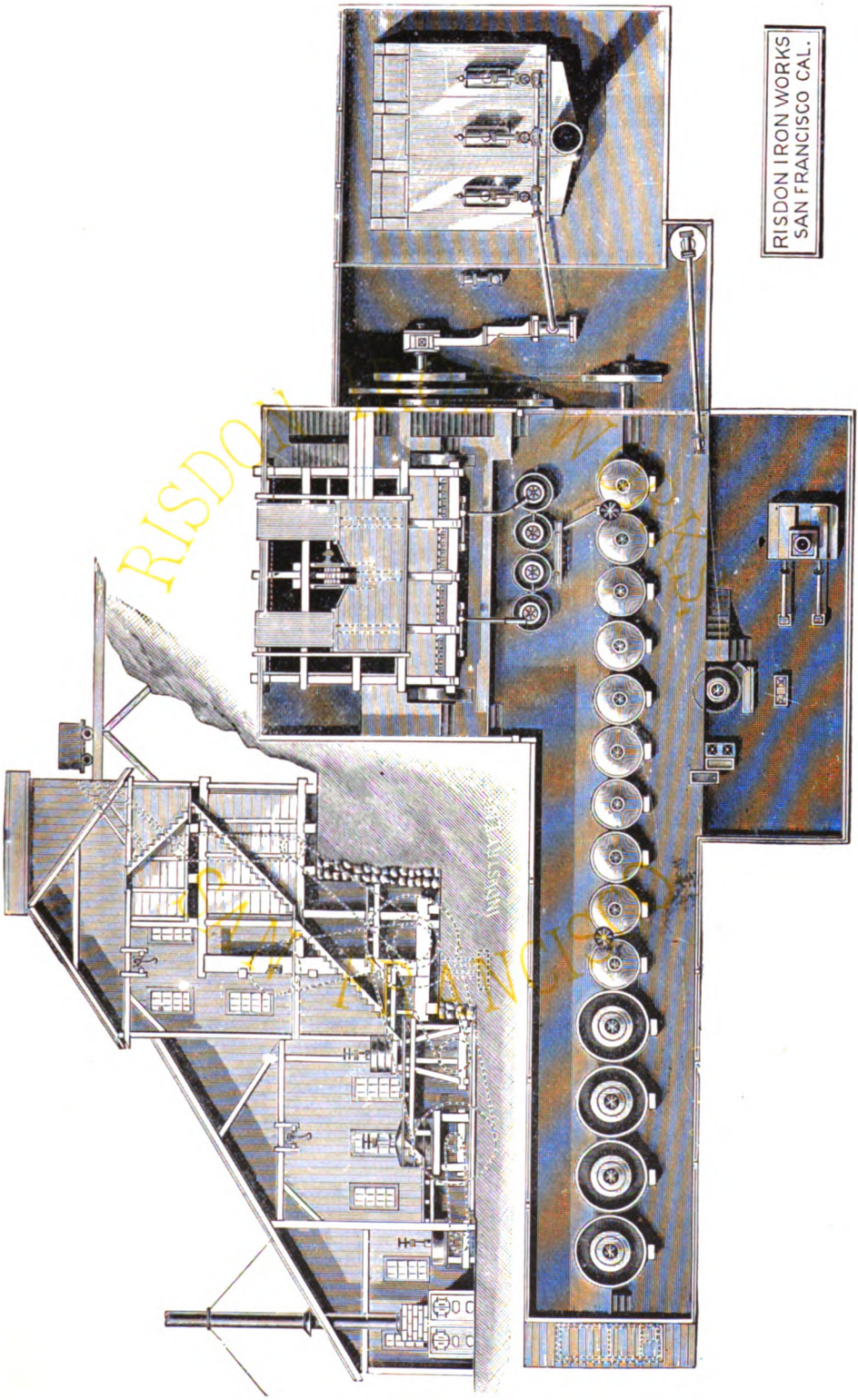


Plate 81.

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20=STAMP WET CRUSHING SILVER MILL

BOSS CONTINUOUS SYSTEM OF AMALGAMATION.

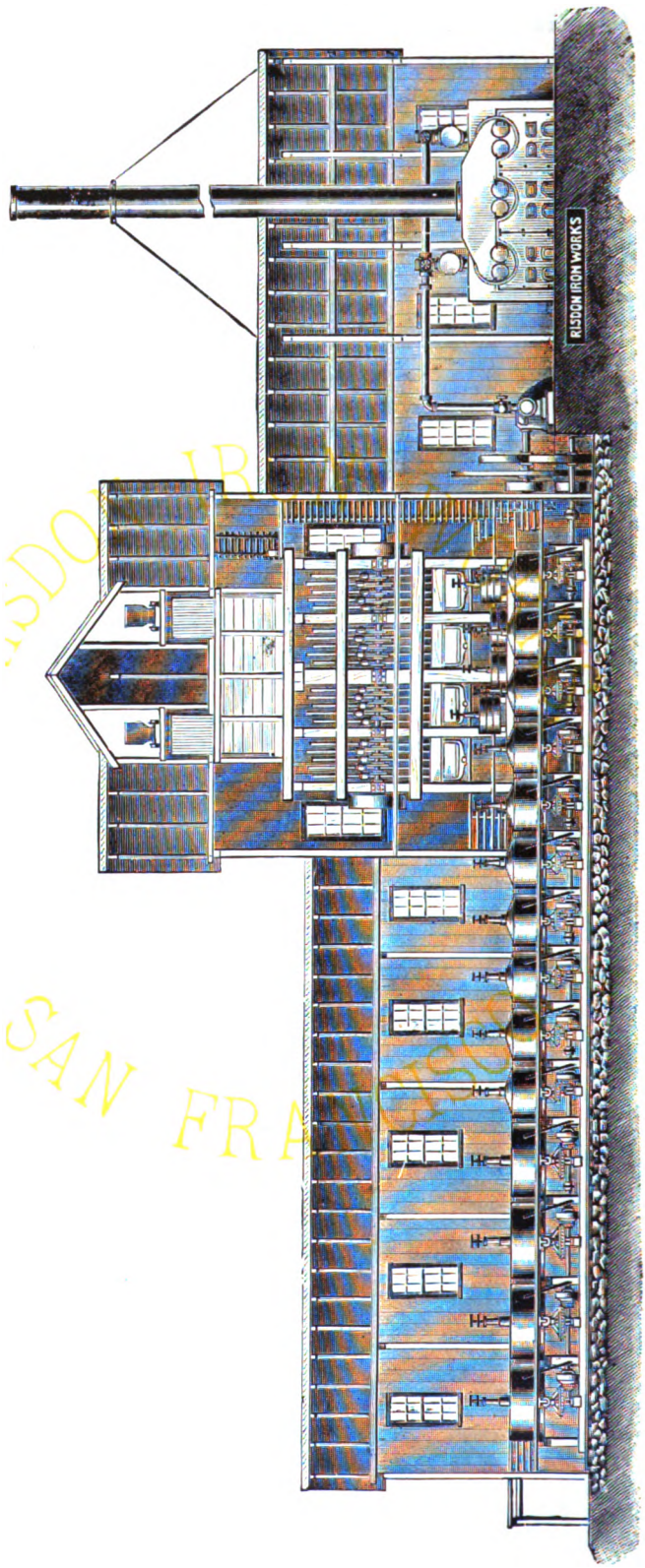


Plate 83.

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THE BOSS CONTINUOUS PROCESS

FOR

AMALGAMATION

The introduction of this system of pan amalgamation into silver milling has been very thoroughly effected, and has proved that it has many excellent features that recommend it, and make it superior in many respects to the tank system of pan amalgamation.

The large saving in labor and in power, the cleanliness, the reduced wear and tear because of the uniformity of the load, together with the reduced space required, and other advantages, make the continuous system of pan amalgamation the favorite with many mine and mill owners.

This system gives an exact and equal distribution of pulp through all the pans and settlers, a thorough and uniform mixture of the chemicals with every portion of the pulp, and a rapidly increasing temperature in the amalgamating pans insuring to each particle of pulp a uniform treatment.

Plates Nos. 81 and 83 illustrate a mill equipped with the system referred to, in which the ore receives precisely the same treatment as in the tank mill until it has been discharged from the battery; from whence it flows through suitable pipes to the first special grinding pan, and thence to and through each grinding pan in the same manner, thence to and through the chemical mixers (where the chemicals are introduced by the chemical feeder), and thence in like manner to and through each successive pan and settler in the order of their arrangement.

The quicksilver supply and its distributing pipes are so arranged that it can be introduced into either of the amalgamating pans as desired.

Steam syphons are provided for cleaning the pans, and for a pass by to cut out any pan from the circuit for repairs.

The cost of erecting the "continuous" mill is much less than the tank mill because of its reduced size it requires less grading and less masonry for retaining walls.

Power is applied to the pans direct from the pan line of shafting through friction clutch pulleys without the use of belts.

All the water from the battery passes through the pans, and consequently all slimes are treated in combination with the sand.

In large mills more than one circuit of pans and settlers may be employed to advantage, each circuit treating a portion of the pulp separately.

Plates Nos. 81 and 83 illustrate a 20 stamp wet silver mill and the arrangement of the continuous system of amalgamation as applied to it.

Plates Nos. 97 and 99 are different views of a 40 stamp dry crushing silver mill with the continuous system applied.

In this mill the hot ore is discharged from the continuous roaster directly into the mixer, when enough water is added to reduce it to the consistency required for amalgamation; grinding pans are omitted; in other respects amalgamation progresses as in the wet crushing mill.

For summarized specifications and approximate weight of various mills, see tables, pages 118 and 119.

Net prices quoted on application.

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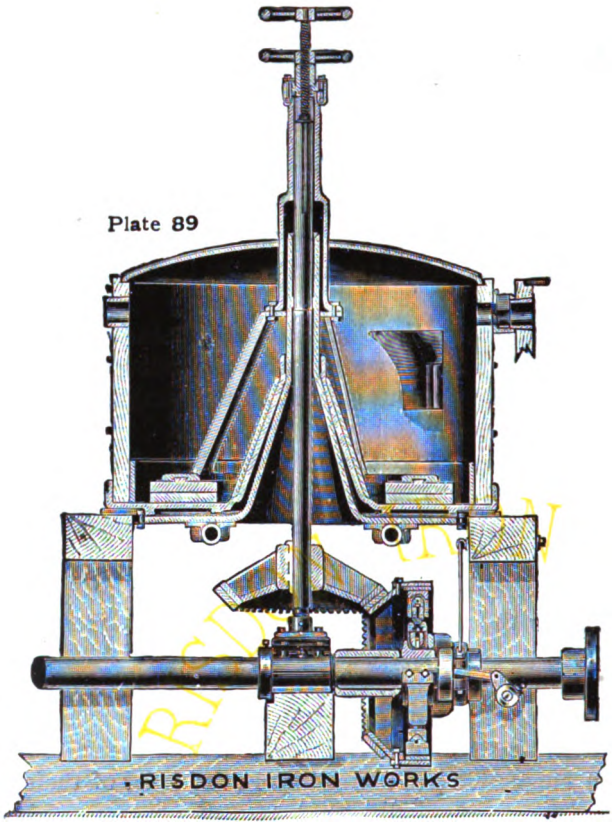


Plate 89

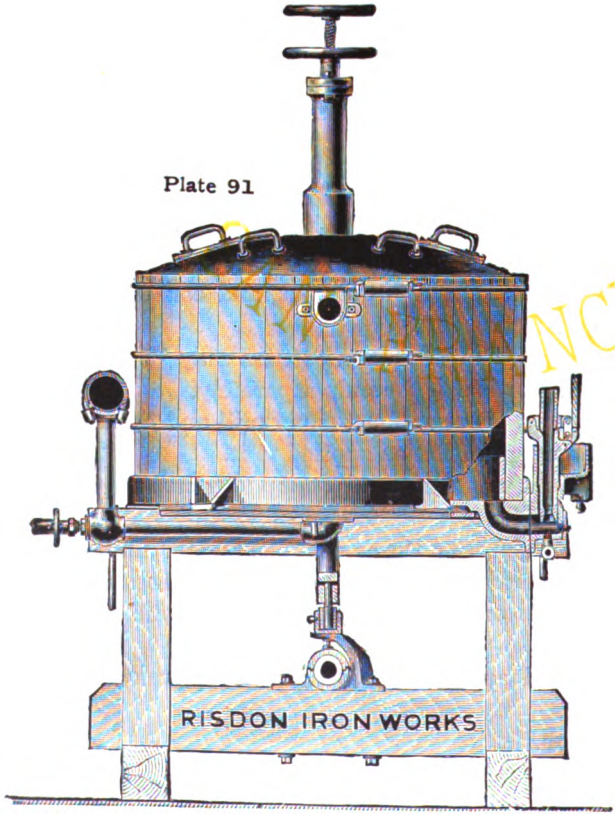


Plate 91

STANDARD AMALGAMATING PAN

As illustrated in plates Nos. 89 and 91, embodies all the latest improvements of value now being used in continuous mills. They are provided with a steam chamber in the bottom and cones, which affords an increased heating surface, making it possible to furnish the required heat with exhaust steam, which is always used with economy when available. The admission and discharge steam valves are so connected as to create a current through the steam chamber which can be regulated as desired.

These pans are built somewhat heavier than the five-foot combination pan, and are provided with a wearing ring of cast iron to protect the inside of the staves at the bottom of the pan, as shown, and also with a cast-iron sleeve to protect the cone as shown. The pan spindle is supported by a bracket cast on the horizontal driving shaft box, and permits of the removal of the shaft without disturbing the spindle.

A section of the front of pan, fig. 91, shows the quicksilver bowl with pan syphon in position for draining pan of quicksilver and pulp, when requiring repairs.

These pans are designed with a view to strength and durability. All parts subjected to special wear are protected as thoroughly as possible.

Diameter, inside, 5 ft. 2 in.

Weight, approximately, 8500 lbs.

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STANDARD SETTLER

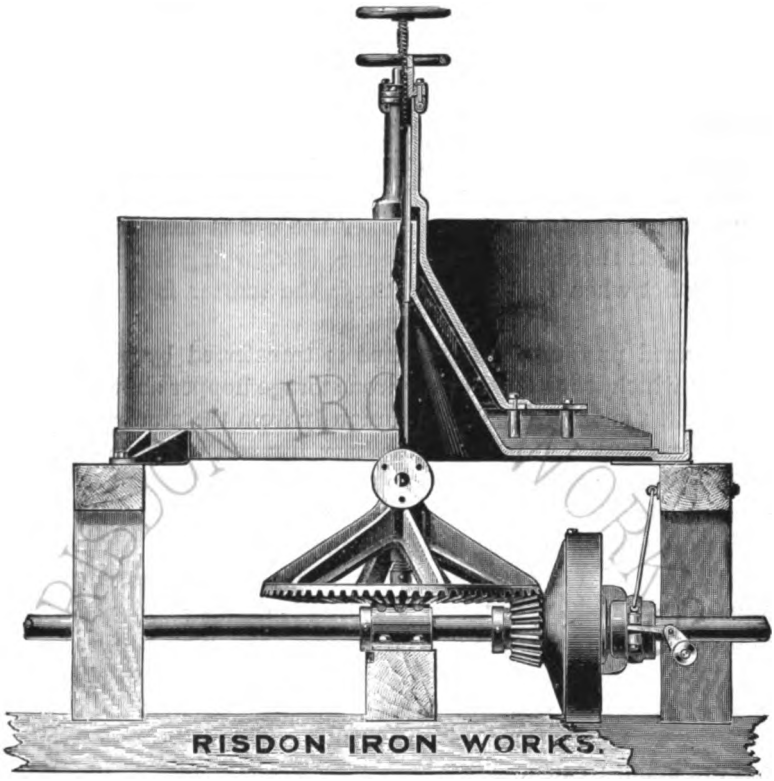


Plate 93

As designed for continuous mills, is illustrated on this page.

The design and construction of this settler differs from the ordinary settler chiefly in detail. The driver and muller arms are cast in one piece, and the muller bolted to them as shown.

They are preferably driven by friction gear.

The shoes work close to the bottom and cone without touching them, and are placed at such an angle as to cause a strong under current, which sweeps the bottom, saving much wear and tear of the parts.

Quicksilver bowls are used, of the same pattern as on the Boss' pans, and to which a syphon can be applied for draining the settlers.

Iron sides are used.

The cone is cast in one piece with settler bottom, and is made of large diameter at base as shown.

The shoes traverse the bottom so thoroughly as to prevent the accumulation of sand, and the troubles resulting therefrom.

Diameter, 8 feet. Weight, approximately, 8200 lbs.

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DRY CRUSHING SILVER MILL

Plates 97, 98, 99 and 101

In working base milling ores that require roasting and desulphurizing to prepare them for amalgamation, the dry crushing mill is employed. Various improvements have been made in these mills; mechanical revolving dryers and roasters have been substituted for the more primitive drying hearths and reverberatory furnaces, effecting a large saving in labor and fuel.

After passing through the rock breaker the ore is fed continuously to a revolving dryer, which thoroughly dries the ore, discharging it into the self feeders; the ore is still hot when fed to the battery: the mortar is usually double discharging.

The pulverized product of the stamps is transferred by screw conveyors to the elevator, by which it is raised to the iron storage hopper above; another screw conveyor feeds the roasting furnace continuously from the storage hopper.

The roasting furnace may be a Bruckner furnace, a Howell-White furnace, an improved White furnace, a Thompson furnace, a Stedtfeldt furnace, an O'Hara furnace, or a reverberatory furnace.

Our illustration shows a Howell-White furnace.

In "continuous" furnaces the ore is roasted while making one passage through the furnace, and the degree of roasting is regulated by adjusting the furnace so as to retain the ore a greater or less time, as may be required.

In "charge" furnaces, such as the Bruckner and reverberatory, the degree of roasting can be varied by increasing or diminishing the time the charge remains in the furnace, which varies from four to twelve hours, as may be required by the character of ore being treated.

The roasted ore is then cooled, and amalgamation follows, on the same plan as in the wet crushing mill, except that less grinding is required in the pans when treating roasted ores.

When the Boss continuous system and a continuous roaster are used in dry crushing mills, a furnace discharger and mixer are used to receive the dry, hot ore from the roaster.

The mixer resembles a settler, or agitator, and simply mixes cold water with the ore, which then flows by gravity to the amalgamating pans; amalgamation then follows, as in the Boss continuous system in wet crushing mills, saving much labor and economizing in space otherwise required for cooling floors.

The term "dry crushing silver mill" is a very broad one, embracing all the possible combinations of the following parts:

Drying the ore may be performed by the revolving dryer, by upright dry kilns, or by horizontal kilns.

Crushing may be by stamps or rollers.

Roasting may be by either of the roasters previously named.

After the roasting either lixiviation or amalgamation may be employed.

Thus it will be seen that no particular specification will do the subject justice.

We are fully prepared to estimate on any desired style or size of a dry crushing mill, the several parts of which are illustrated elsewhere in this catalogue.

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Plan of 40-Stamp Dry Crushing Silver Mill.

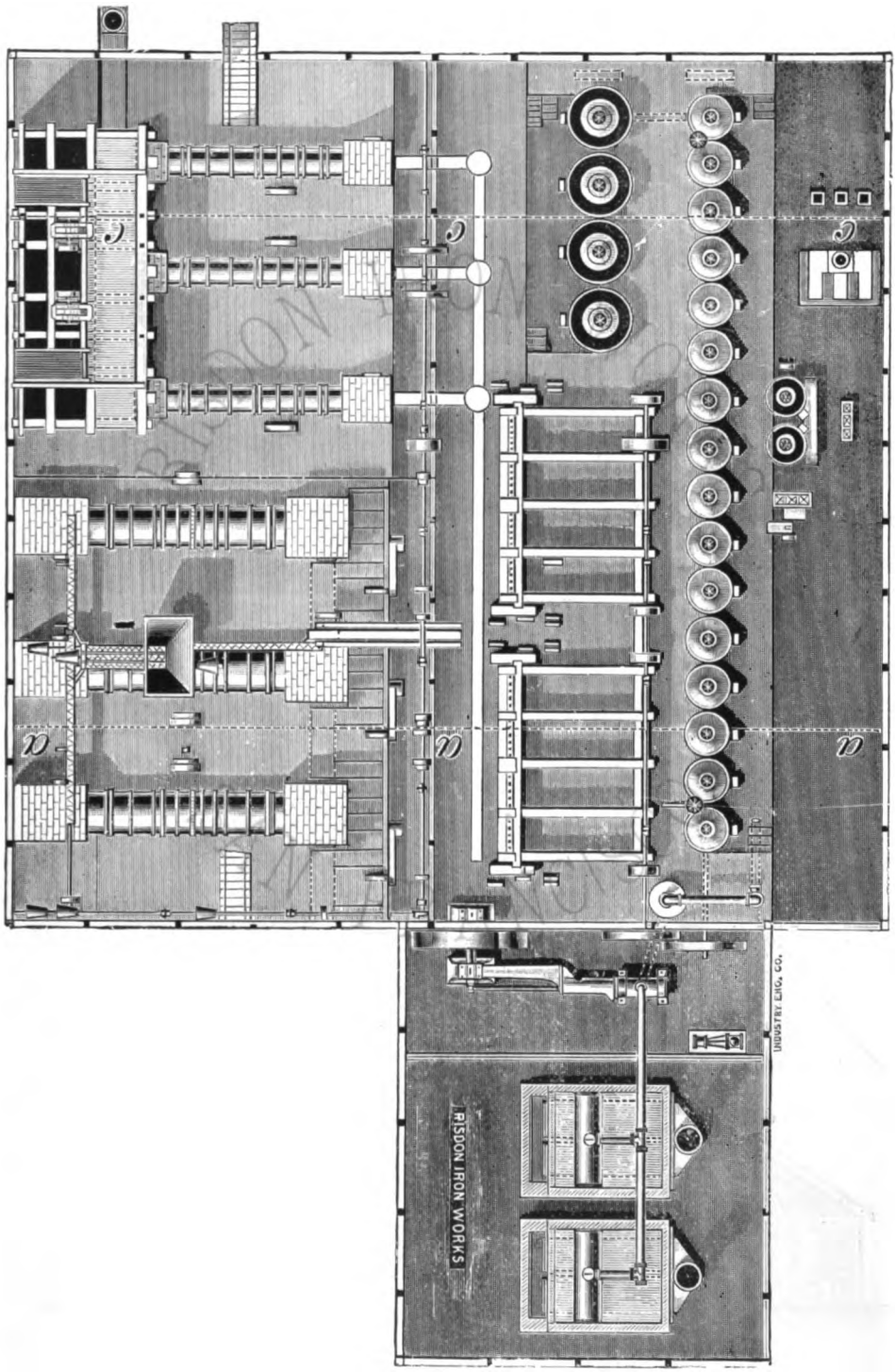


Plate 97.

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40 STAMP DRY CRUSHING SILVER MILL.

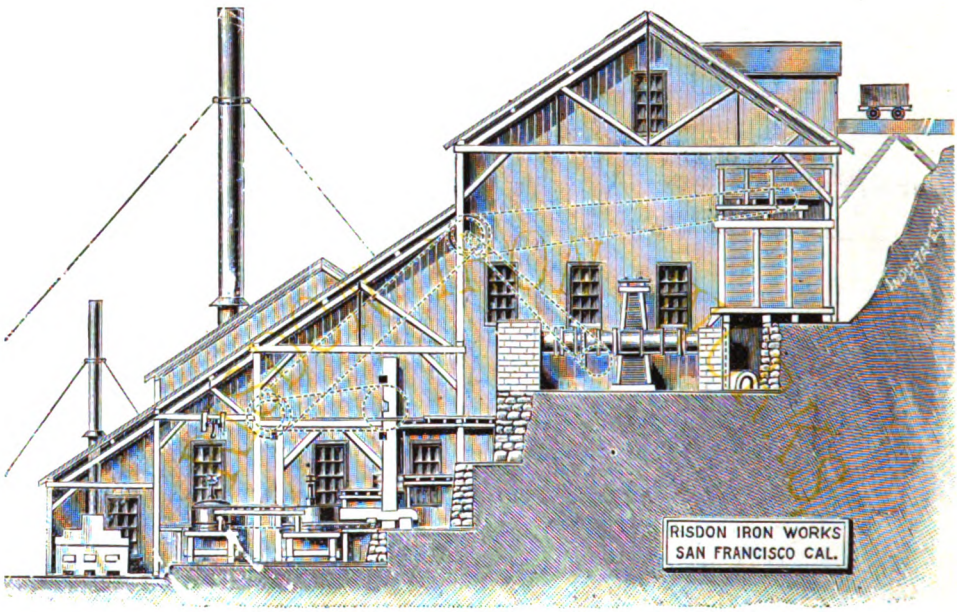


Plate 98
Cross Section at C C

40 STAMP DRY CRUSHING SILVER MILL.

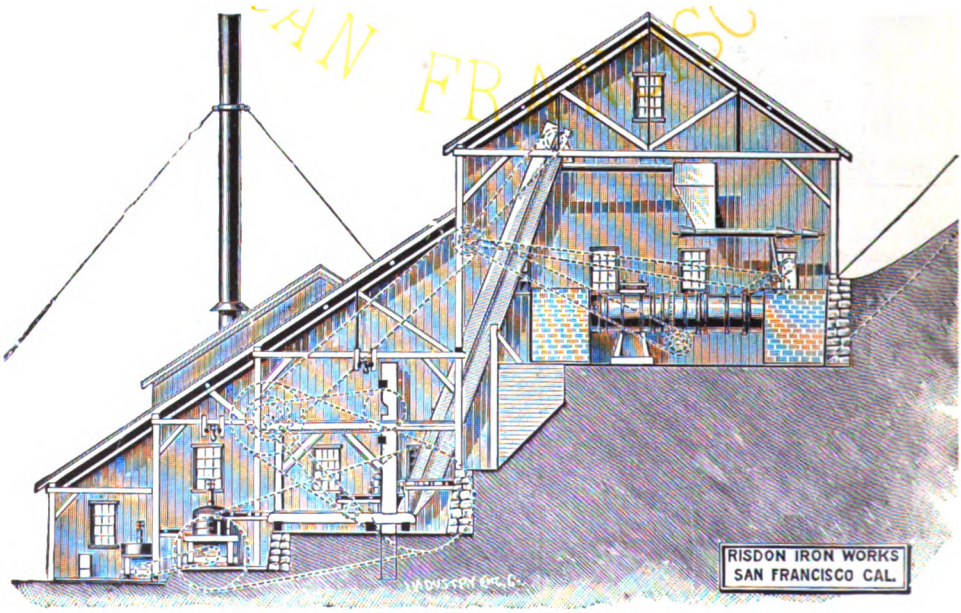


Plate 99
Cross Section at A A

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CROSS SECTION OF

DRY CRUSHING SILVER MILL

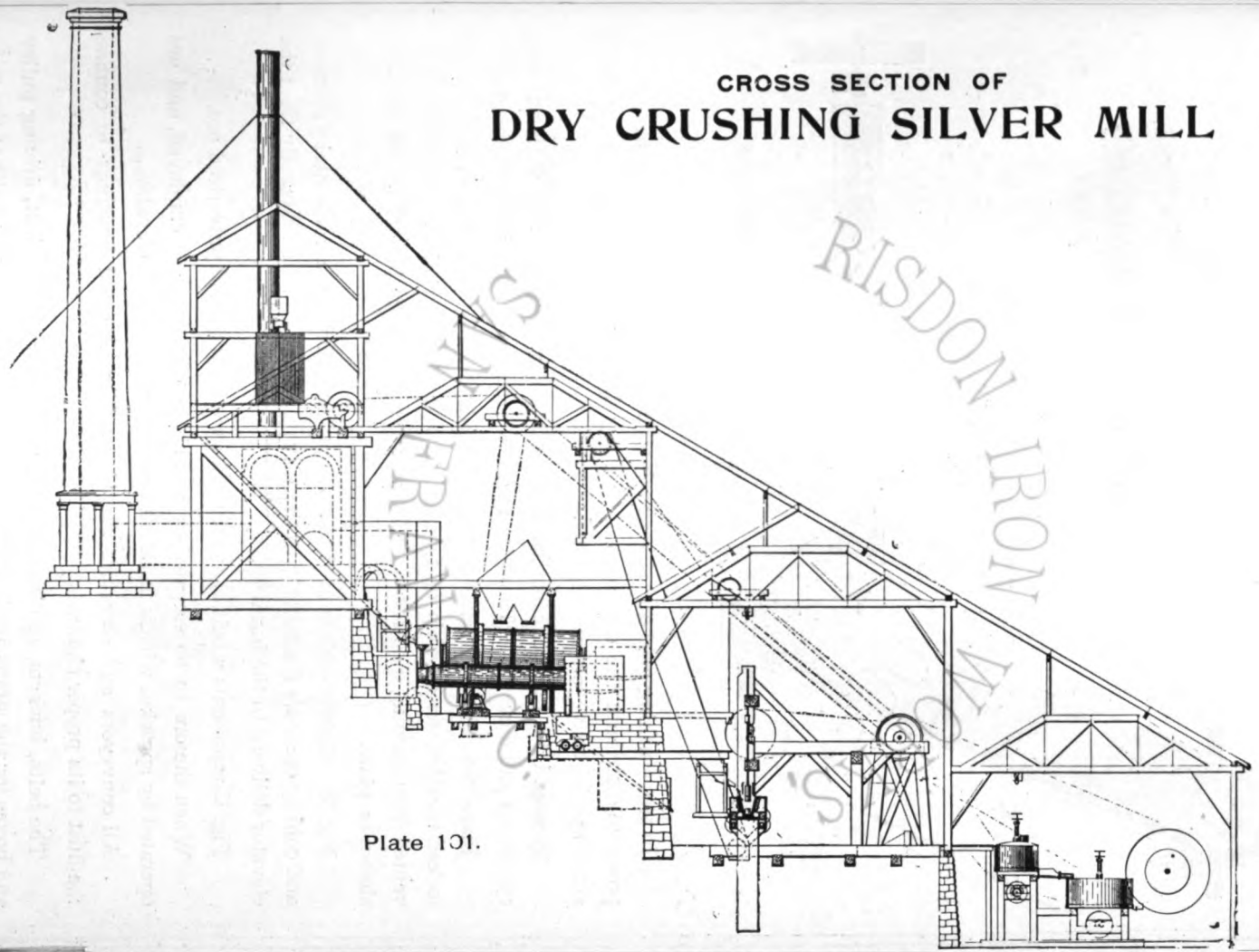


Plate 101.

RISDON IRON WORKS
SAN FRANCISCO, CAL.

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JOHNSTON

CONVEYOR AND ELEVATOR

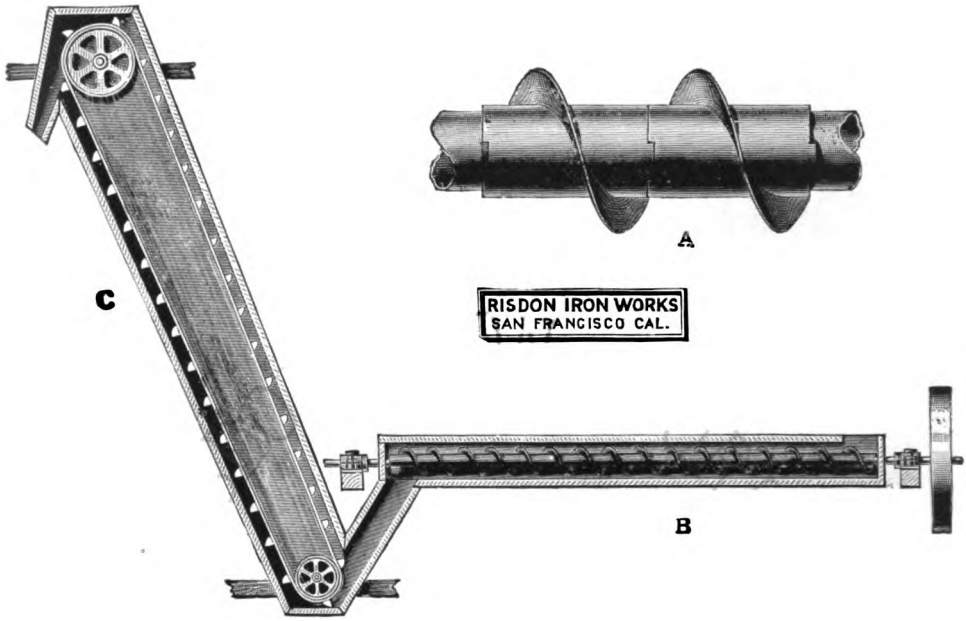


Plate No. 102

In wet crushing gold and silver mills, the law of gravitation furnishes ample power to distribute the ore and pulp to every department of the mill without the aid of special conveyors and elevators.

It would be impracticable to construct a dry crushing mill without both conveyors and elevators. Hence they are a necessity in every dry crushing mill.

Plate No. 102 illustrates a Screw Conveyor, Fig. A, built in flights and locked together on an axis of tubing. The flights are held together and prevented from turning on their axis by suitable fastenings placed at the ends, as shown in plate.

Fig. B. Conveyors are used to move pulverized ore in a horizontal direction, and convey ore from the battery to the elevator "Boot," and frequently from the elevator delivery to the furnaces.

Fig. C represents a belt elevator used for elevating cold pulverized ore.

When the ore to be elevated is hot, chain elevators are employed, and are operated by sprocket wheels in the same manner as the belt elevators.

All conveyors and elevators are "housed" with wood housings to confine the dust to its proper channels.

The belts, buckets, and bolts, straps, pulleys for elevator belt, driving pulley and boxes for the straps are furnished by us, and the wood work built at the mill.

The capacity of elevators depends upon the size and number of buckets and speed of the belt.

The capacity of conveyors, upon their diameter pitch and velocity.

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IMPROVED REVOLVING ORE DRYER

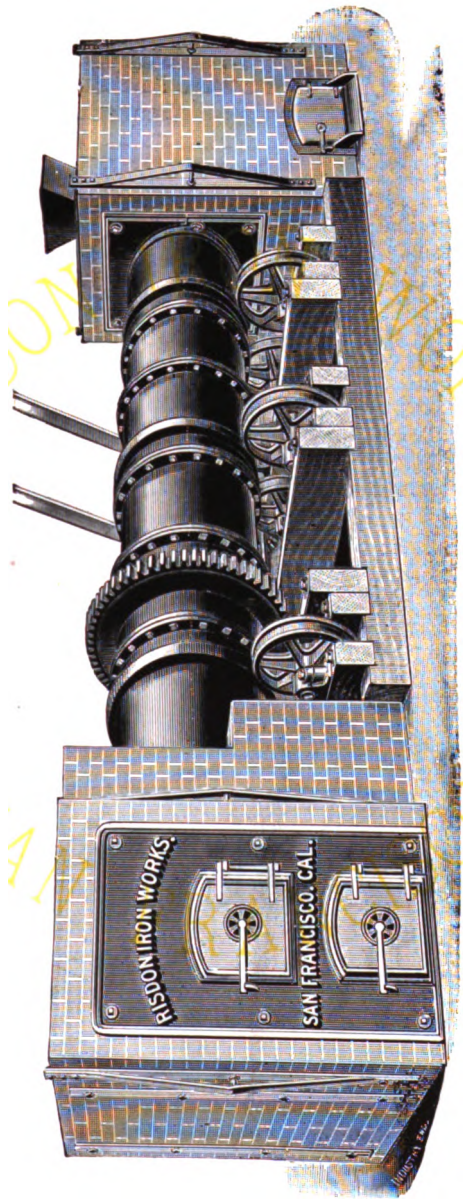


Plate 103

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REVOLVING ORE DRYER

Ores are usually delivered at the mill directly from the mine, and contain a large but varying percentage of moisture, which must be extracted before the ore is fed to the battery of a dry crushing mill, so as not to choke the battery screens and prevent the free discharge of the pulverized ores from the mortar as they are crushed.

Iron hearths, heated by furnaces arranged under them, were formerly used for this purpose. The wet ores were spread over them by hand, where they remained until thoroughly dried, and were then removed by hand labor to the battery feeders.

This method required too much house room and labor to be economical, and has given way to the Revolving Dryer, illustrated in cut No. 103. This dryer is automatic and continuous in its operation; it is cylindrical in form, having a slight taper. Its large diameter is at the furnace end, and ore from the crusher is fed to the hopper at the small end.

The cylinder's axis is placed horizontally, but, owing to its conical form, the ore travels gradually toward the fire at the large end.

Spirally arranged projections are placed inside the cylinder to raise the ore and shower it through the flames, assisting to quickly and thoroughly dry it.

The dried ore is discharged into a pit, from which it is drawn through iron lined chutes to the battery feeders.

When sufficient elevation for chutes is not available, suitable conveyors are used.

The size of dryer most used is 44 inches diameter at large end, and 36 in. to 30 in. at small end, and from 16 to 24 feet long.

The shipping weight of an 18-foot dryer is approximately 19,000 pounds, and its capacity from 30 to 45 tons per day; capacity of a 24-foot dryer, 40 to 55 tons.

In furnishing estimates we include cylinder, gears, shafts, boxes, rollers, pulleys, sole plates, front, grate bars, doors and frames for same, hopper, spout, binders and tie rods. All fitted and complete.

From 1,100 to 1,500 fire bricks are required to line the cylinder, and from 10,000 to 14,000 common bricks for setting.

THE SHELF DRY KILN

Is sometimes used as an ore dryer.

It is built of masonry in the shape of a vertical shaft, of one or two compartments. In each of these shafts a series of five cast-iron shelves (each about 2½ by 5 feet) are arranged zig-zag above each other, so that when the ore is admitted from the feed hopper at the top it must pass over each plate in its passage by gravity to the bottom chute, where it is discharged into the usual conveyor to the battery feeders. These dry plates are placed at an angle of 38 degrees from horizontal.

Suitable openings are provided in the walls, through which to remove obstructions, which are liable to occur by the clogging of ore.

The hot gases from the furnaces are admitted under the top shelf, and thence downward through the shaft and between the ore shelves, each space communicating with the next one by a flue arranged in the sidewall of the shaft.

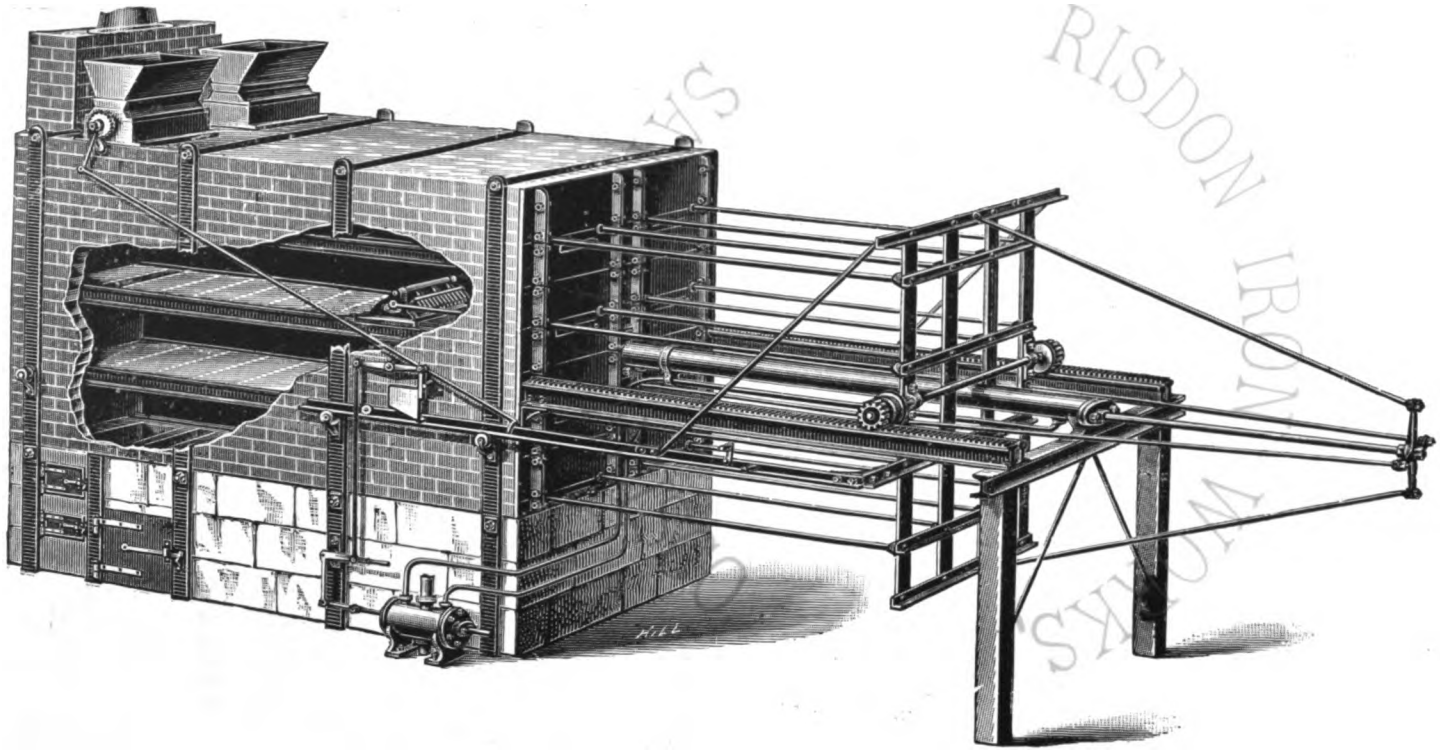
These flues being located on alternate sides of the shaft, form a continuous passage for the gases, which are discharged into the chimney at the base of dry kiln.

These dryers are somewhat cheaper than the revolving ones, but require more attention to operate.

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AMERICAN-SPENCE MECHANICAL FURNACE

For Chloridizing and Desulphurizing all Pyrite Ores.



We Build a Number of Modifications of Spence Furnace for Copper Desulphurizing.

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HOWELL—WHITE

ROASTING FURNACE

Plate 105 is an improved White furnace, continuous and automatic in its operation, and consists of a long cast-iron revolving cylinder, slightly inclined toward the fire end, and fed at the upper end with dry pulp from the stamps or other pulverizers by means of a suitable screw feeder, placed between the feed hopper and cylinder.

The cylinder is made in sections to facilitate its transportation. About one-third of its length has an increased diameter, and is lined with fire bricks to protect it from the extreme heat to which it is exposed at the fire end. Spirally arranged projecting bricks are built in with the lining for the purpose of circulating the ore through the heat and flame. The smaller part of the cylinder is also provided with internally projecting cast-iron shelves, arranged so as to insure a better circulation of pulp during its passage through the furnace.

The cylinder is supported on a system of rings resting on friction wheels, and guided in a central position by rollers in upright frames, and revolved by friction of the wheels operated by gears and pulleys as shown.

Among the advantages claimed for this furnace, we name the following:

It is continuous and automatic in its operation, discharging its product regularly into a hot ore bin at the lower end, from whence it is drawn as required.

The ore is submitted to a gradually increasing temperature during its passage through the furnace, which is the correct theory of roasting.

By changing the inclination of the cylinder the ore can be retained a longer or shorter period, as may be necessary.

An auxiliary fire is sometimes used with these furnaces for roasting the dust, which escapes from the main furnace.

We furnish complete iron work for these furnaces, consisting of cylinder, frictions, gears, shafts, bearings, frames, guide stands, rollers, pulleys, plates, fire doors, fender discharge doors, grates, binders, tie rods, feed hopper, flue doors, bolts, etc., complete. All estimates include all the iron work named, as well as cylinder brick.

TABLE OF SIZES, WEIGHTS AND CAPACITIES

No.	Diam. Inches	Length Feet	Capacity Tons	Revolutions per Min.	Fire Brick for Cylind'r lining	Total Weight Iron. Lbs.	Price
1	40	24	15 to 20	7 to 10	1300	22,500	$
2	52	27	20 to 30	5 to 8	1700	34,000	
3	60	27	30 to 50	4½ to 7	2100	39,000	

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THE HOWELL-WHITE ROASTING FURNACE.

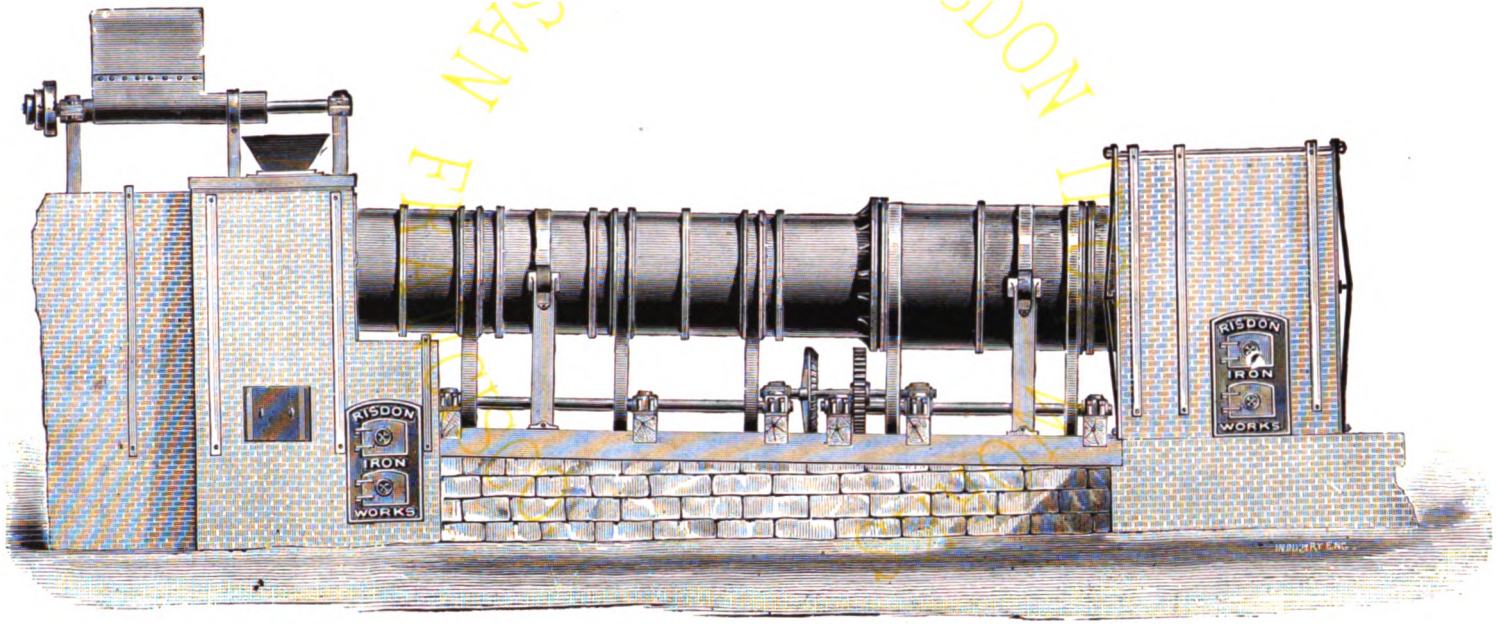


Plate 105.

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IMPROVED BRUCKNER FURNACE

Plates No. 107 and 108 are section and plan of a Bruckner Roasting Cylinder, 7 feet diameter and 18 feet long.

Two heavy chilled iron or steel rings are secured to the cylinder. Each ring rests on two friction rollers, which carry the entire weight of cylinder and charge. Suitable mechanism is provided to operate these rollers, which drives the cylinder by friction at the necessary speed.

The ore is introduced into the cylinder through two charging doors, which must be placed directly under the gates in the charging hopper, which is fixed over the cylinder.

This hopper is of iron supported by cast-iron columns, and of sufficient size to contain the quantity of ore required for one charge of the cylinder.

The cylinder contains a charge of 7 to 10 tons of ore, which remains until thoroughly roasted and chloridized. It is then discharged at the bottom into suitable cars, and taken to the cooling floor, or may be dumped into a storage bin beneath the cylinder, where it can remain, utilizing the heat it has received in the furnace, until drawn off as required for cooling and amalgamation or chlorination.

A brick fire box is shown in the cut. We also build iron fire boxes mounted on wheels and lined with fire bricks.

The iron fire box runs on tracks at right angles to the axis of the cylinder, thus admitting of its removal to one side when the furnace is not in use, and affords ready access to the interior of the cylinder for repairs. As the cylinder revolves, the ore is thoroughly circulated and exposed to the flame and heat.

The time required for roasting a charge of ore depends entirely on the character of the ore being treated.

This form of roasting cylinder permits of retaining the charge of ore any length of time that its nature requires.

We have built various sizes and styles of these furnaces. The 7 feet diameter by 18 feet long is considered the standard size and is used more than any other.

Our estimates for Bruckner furnaces include cylinder complete (without fire back), lining, charge hopper, iron columns, driving gear, guide rollers, iron fire box on wheels, foundation rods, buckstays, bolts, washers, including all the iron work for a complete furnace, but not the discharge cars or discharge bin irons, and do not include fire bricks except specially mentioned in bid.

Iron work for 8x18 feet approximating 39,000 lbs.; fire bricks for lining, 2,700; common brick for setting, and 10 feet dust flue, 25,000; fire clay, 4 barrels.

Complete iron work for a 7x18 foot furnace weighs approximately 31,500 lbs., and requires 1,700 fire bricks for furnace linings; 20,000 common bricks for furnace setting, including 10 feet of dust flue; fire clay, 3 barrels.

Iron work for a 6x12 foot furnace weighs approximately 18,000 lbs.; fire brick for lining, 1,300; common brick for setting, and 10 feet of dust flue, 18,000; fire clay, 3 barrels; capacity, 3 to 4 tons per charge.

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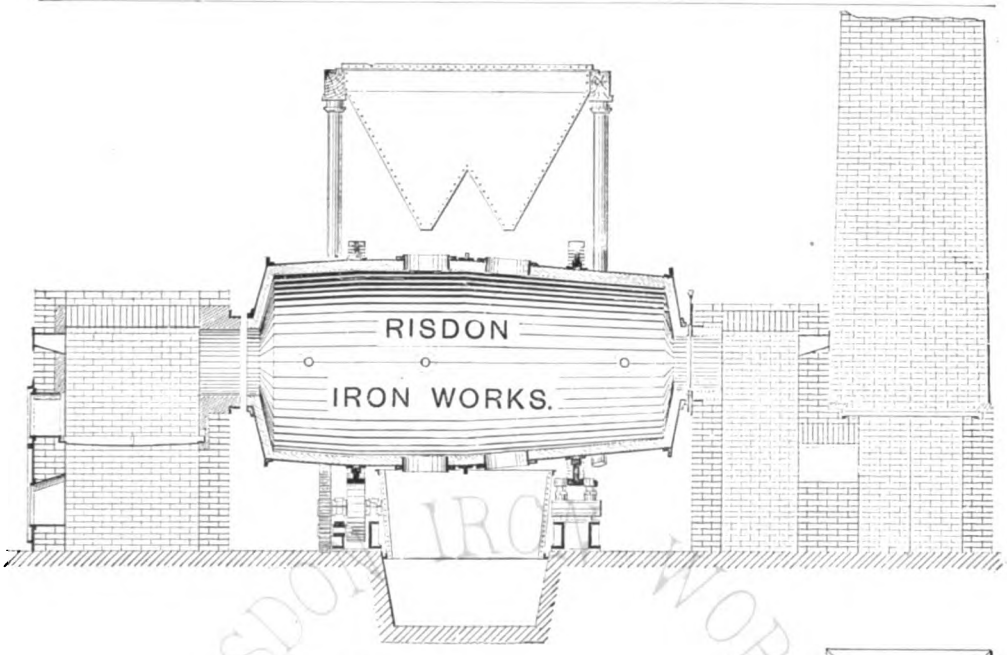


Plate 107

IMPROVED BRUCKNER FURNACE

FOR ROASTING, CHLORIDIZING, OR DESULPHURIZING.

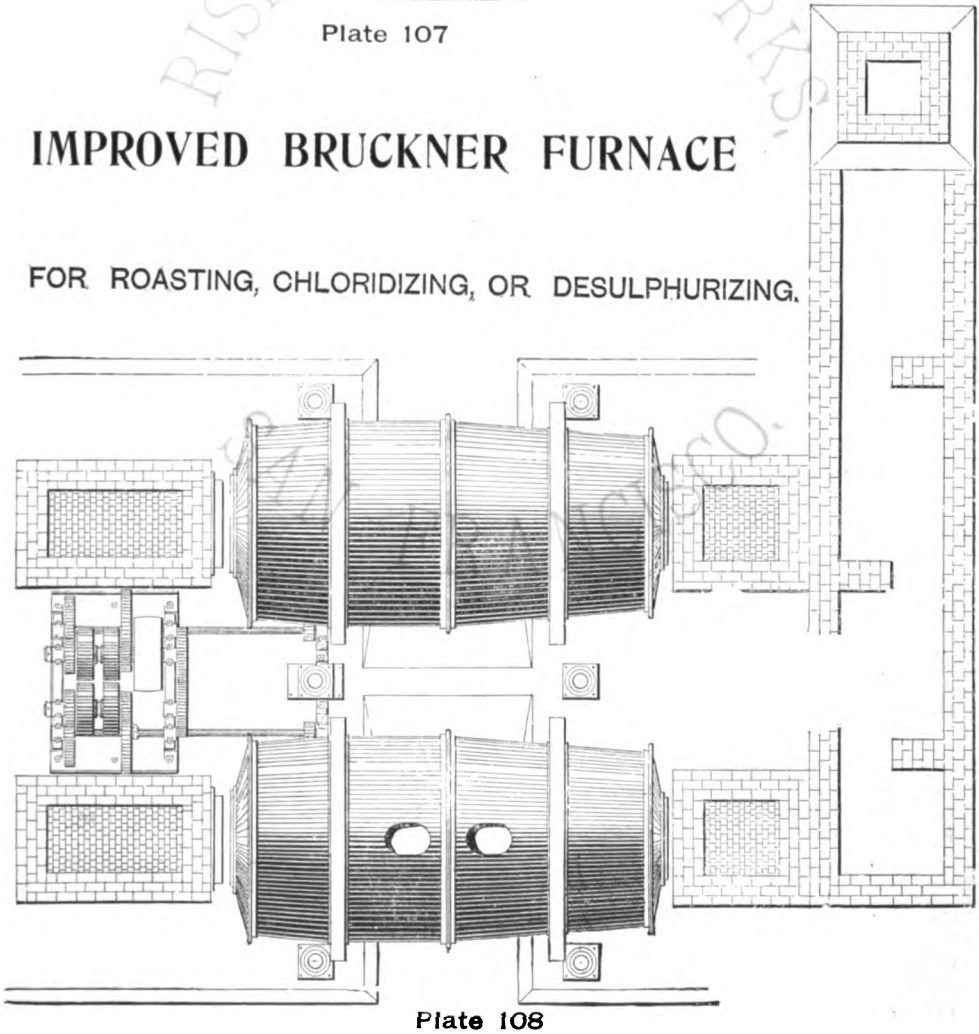
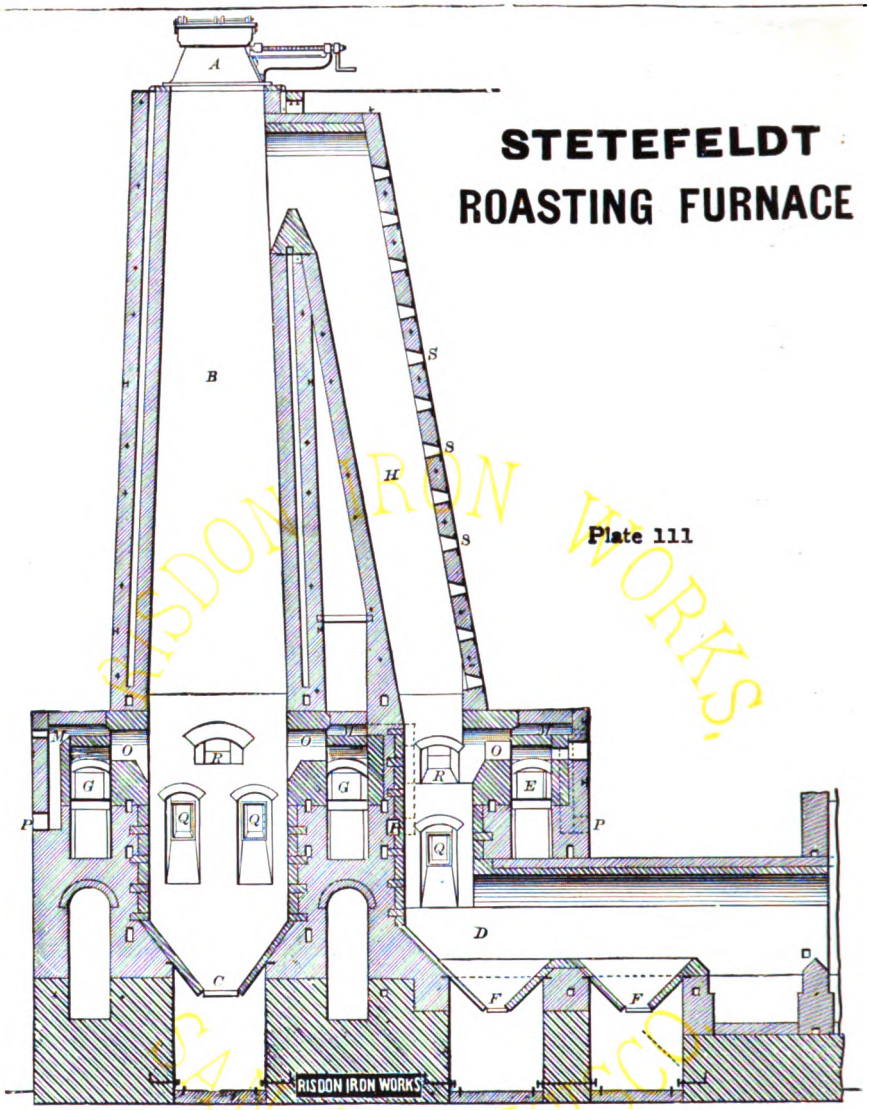


Plate 108

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For Simultaneous Roasting and Chloridizing. Consists principally of a vertical roasting shaft, with its gas generators, pulp feeder and discharge, and a descending dust flue, with its gas generator and auxiliary dust chambers.

Pulp is fed continuously through a suitable screen on top of shaft, showering slowly toward the bottom through the ascending current of ignited gas in the roasting shaft; it is heated, desulphurized and chloridized during its descent, having been mixed with salt before being fed to the furnace. Roasting continues while the ore remains in the hot ore chamber at the bottom, from whence it is drawn and cooled as desired.

——	No. 1	No. 2	No. 3
Castings	15,800 lbs.	13,600 lbs.	9,600 lbs.
Wrought iron and bolts	8,800 "	6,150 "	4,850 "
Buckstays, bars, etc	22,500 "	13,200 "	11,800 "
Total weight, lbs.	47,100 "	32,950 "	26,250 "
Capacity in tons, 24 hours	30 to 60	20 to 40	10 to 20
Stone for erecting, cubic feet	3,000	2,500	2,000
Common brick	260,000	210,000	150,000
Fire brick	4,000	3,500	2,500
Price f.o.b.		$	$

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THE O'HARA

Roasting and Chloridizing Furnace

Consists of two horizontal hearths, usually about 60 feet long by 8 feet wide, built of masonry, arched over the hearths, which are built parallel, one over the other, with the least possible space between the roof of the lower and the hearth of the upper, so as to confine the heat close to the ore.

Attached to two endless chains, at suitable distances apart, are iron triangular frames, to which a number of plows or hoes are attached, so that one set turns the ore toward the center and the following set turns it in the opposite direction, a set of plows passing a given point two to three times every minute, exposing a new surface of ore to the flames and gases.

The operation of the furnace is as follows: The ore is fed continuously from the battery into the furnace hopper, through which it passes to one end of the upper hearth. The plows actuated by the endless chains stir the ore on the hearth, and move it gradually to the opening at the other end, when it falls to the lower hearth, where the returning plows repeat their operation on the lower hearth, discharging the roasted ore into a suitable hot ore bin or car near the feed end of the furnace.

The furnace is so arranged that the flame and gases traverse the entire length of both hearths in the opposite direction to the ore, which is subjected to the greatest heat at the time it is most required to finish the roasting.

As the ore passes through the upper hearth it is thoroughly desulphurized by the heat furnished by the furnace as described, and the combustion of the sulphur in the ore. This action is assisted by the oxygen in the supply as admitted at intervals through the sides of the furnace by suitable openings.

For a chloridizing roasting, salt is mixed with the ore as it is fed into the hopper. Ordinarily the ore will be from five to ten hours passing through the furnace, according to its character.

This furnace is automatic and continuous in its operation, and requires comparatively little attention. Only one man is required to attend the fires, no other labour being necessary when mechanical feeder and elevators are employed to deliver the ore at the furnace and from there to the amalgamating pans.

A separate power is required, so as to regulate the speed at will.

These furnaces are built in three sizes: 20, 40 and 60 tons capacity, the 40-ton furnace being generally used.

Materials for a 40-Ton Furnace

Bolts	1,100 lbs.
Wrought iron	6,600 "
Cast iron	3,000 "
Brick for furnace	137,000
" " stack	75,000
Stone	250 perches
Total length	120 feet
" width	14 "
" height	11 "
Horse-power required	3

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The Leaching or Lixiviation Process.

This process consists in first roasting with salt to convert the silver into chloride, then dissolving the chloride of silver in a solution of hyposulphite of soda, precipitating it with sulphide of lime or soda, as a sulphide of silver, and then refining this latter product. The Russell process is a modification of this, consisting chiefly in the addition of a certain proportion of sulphate of copper to the hyposulphite solution. The leaching process has some advantages over roasting amalgamation in lower cost of plant and process; but the chief objection to its use comes from the facts that the reactions involved are often complicated, and sudden disturbances in the working are introduced by small changes in the character of the ore. A thorough chemical knowledge is necessary to successfully carry out the process under changing conditions; and as this must be combined with the practical experience and good judgment equally necessary in a manager, it follows that there are few men available for taking charge of such works, while this difficulty does not exist with the roasting amalgamation process.

The cost of the process is from $5.00 to $12.00 per ton, and saving from 80 to 90 per cent.

Since this process was introduced in Mexico, in 1868, by Mr. Ottokar Hofmann, it became so extensively used, that at present it is one of the important processes for reducing refractory silver ores on the American continent.

All silver ores can be treated by this process, except those that contain so much lead that they are classed as smelting ores, and ores which on account of a clayey gangue do not permit a free filteration. The latter kind, however, can be treated without difficulty if it is first subjected to a slight concentration by which the silver bearing minerals are freed from the clay. We give here a brief description of the manipulations and the chemicals used.

DETAILS OF OPERATIONS

(1) **CRUSHING.**—The ore is first pulverized. Though this is a mere mechanical operation, it is not prudent to decide always in favor of that pulverizing machine which will in a given time, crush largest amount of ore at the least cost, because the most important part of the process, the roasting, depends to a great extent on the physical condition of the ore. Ores which contain considerable argentiferous zincblende or galena require to be pulverized very fine in order to permit a satisfactory chlorination while even a coarser pulp of pyrites and copper ore will chlorodize well. Therefore in selecting a pulverizing machine due attention should be paid to the character of the ore. This refers as well to the amalgamation as the lixiviation process.

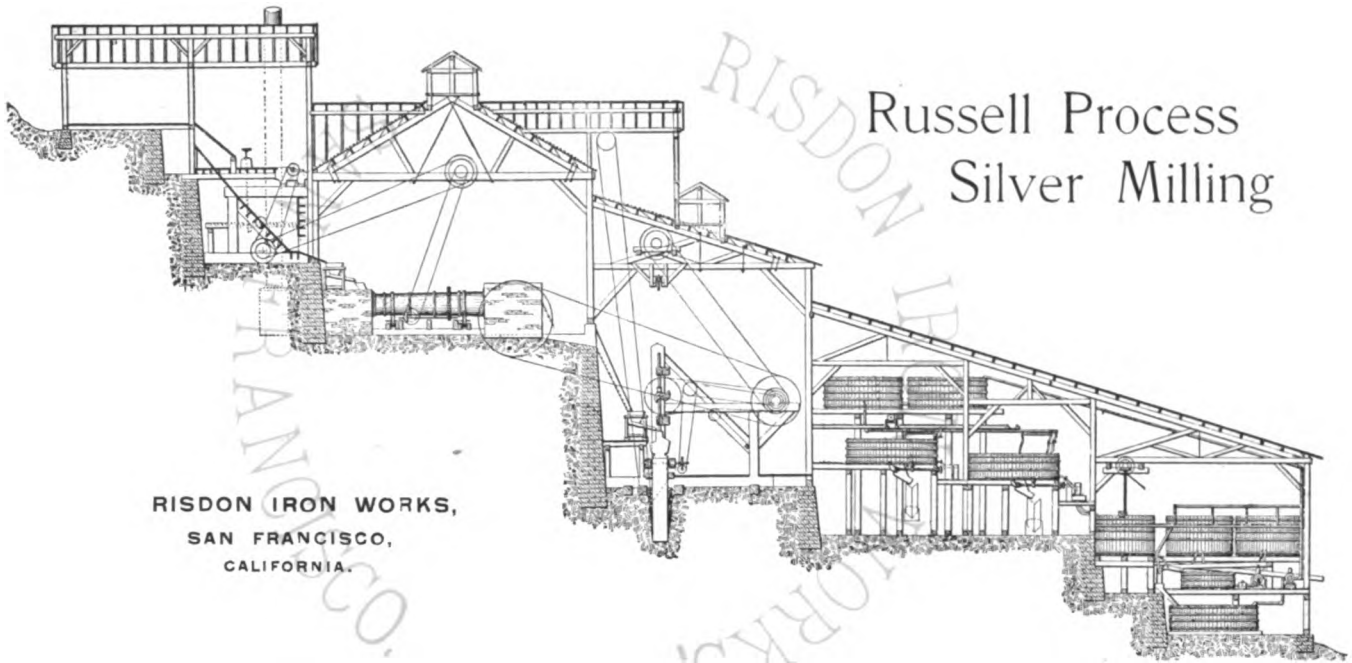
The principal pulverizers in use are the stamp batteries, and the rolls. The rolls produce a much more uniform grain than the battery, and we find in the pulp, the ore and gangue particles more of an even size, which is of great advantage to concentration, but not always so to roasting. The most suitable condition of the pulp for roasting usually is, if the ore particles are very fine and the gangue coarser. Such a pulp is produced by the stamps. The ore, as a rule, has a greater specific gravity than the gangue, and cannot so easy evade the blows of the dropping stamps than the lighter material. It will, therefore, remain longer exposed to the action of the stamps. Furthermore, the stamps will not readily throw the heavy ore particles against the screen until reduced to a very fine pulp, while the lighter gangue will be discharged when yet much coarser. In roasting, the ore undergoes a chemical decomposition, and it is apparent that this decomposition can be accomplished quicker and better if the particles are very fine. The pulp reduced by stamps is, therefore, in a more suitable condition for roasting than an ore pulp reduced by rolls. The fine condition of the pulp does not interfere much with the subsequent lixiviation because most ores after chloridizing in the furnace, become sandy, and filter freely if the gangue is not clay.

Mr. Ottokar Hofmann, by working the San Francisco del Oro ore, at Parral, Mexico, which contained 37 per cent. zincblende, and 13 to 19½ per cent. galena, found that by crushing through battery screen No. 20 he obtained 27 per cent. less chlorination than by crushing through No. 40 and that the coarser pulp required much longer time to roast than the finer. He sifted the pulp obtained through the above two screens, though sieves of different fineness, and obtained the following figures:

ORE CRUSHED THROUGH

Battery Pulp sifted through Sieve No.	Battery Screen No. 20	Battery Screen No. 40	Battery Screen No. 20	Battery Screen No. 40
	Percentage of the material passing through the sieve.		Percentage of the material remaining on the sieve.	
30	93.8	100	6.2	0.0
40	87.3	100	12.7	0.0
60	78.8	98.95	20.2	1.05
80	71.3	93.8	28 7	6.20
90	67.1	90.50	32.9	9.50

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DRY CRUSHING OR LIXIVIATION MILL.

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These figures show how exceedingly fine a heavy ore is crushed in a battery even through a screen with comparatively coarse meshes. The ore crushed through No. 20 have a material of which 67.1 per cent. were finer than sieve No. 90: still no satisfactory chlorination could be obtained. In order to chloridize well, the ore had to be crushed through battery screen No. 40, which furnished a pulp of which 90½ per cent. passed through sieve No. 90. To produce such a fine pulp with rolls, would require so extremely fine screens, that the use of them would be impracticable. Such fine crushing, however, is necessary for certain ore, and it is therefore not prudent to adopt rolls regardless of the nature of the ore.

(2) ROASTING.—In order to convert the silver into silver chloride, in which state it is soluble in a solution of sodium hyposulphite, the ore has to be roasted with an addition of salt. To roast successfully a sufficient quantity of sulphuretted minerals must be present, as the sulphurets by decomposition produces sulphuric acid, which acts on the salt and liberates the chlorine necessary for the formation of silver chloride. The Base metals of the ore are converted into oxides, chlorides, and sulphates. The required amount of salt depends on the character of the ore, and varies from 4 to 10 per cent. Roasting is the most important part of this process, and has to be conducted with great care. The salt is either added to the ore before it enters the furnace, or after it has reached a certain stage of oxidizing roasting. The selection of the proper roasting furnace should be made by an experienced metallurgist.

LIXIVIATION.

(2) BASE METAL LEACHING.—The roasted ore is moistened with water and charged into wooden tubs in charges of 10 to 15 tons. These leaching tubs are provided with a central discharge around which a filter bottom is arranged in the shape of a very flat funnel. The filter cloth is kept in place by ropes driven into grooves around the discharge hole, and the inner periphery of the vat near the filter bottom. The vat is furthermore provided with an outlet under the filter bottom, and has a slight inclination towards this outlet.

The charge of roasted ore is leached with water, to remove the soluble base-metal salts. Water does not dissolve silver chloride, but a concentrated solution of base-metal chlorides does, and therefore it is advisable not to make the leaching vats too deep as otherwise a too concentrated base-metal solution is produced by the water in descending through a thick layer of ore. The base-metal leaching is completed when a few drops of calcium polysulphide poured into some of the outflowing solution does not produce a precipitate. This part of the process takes according to the character of the ore, from 4 to 8 and 10 hours.

SILVER LEACHING.—The base-metal salts being removed, a stream of diluted solution of sodium hyposulphite is allowed to enter on the top of the ore. Sodium hyposulphite dissolves readily silver chloride. When the outflowing solution shows indications of silver, which also can be determined by an addition of a few drops of calcium polysulpide, the stream is conveyed to special tanks (the precipitating tanks) in which the silver is precipitated as silver sulphide, by an addition of calcium polysulphide. To facilitate and hasten the settling of the silver precipitates the precipitation tanks are provided with machine stirrers, by which the solution can be vigorously agitated. After precipitation, the sodium hyposulphite solution is again in its original condition, and is therefore, after the precipitate has settled, decanted from the latter into tanks placed on a lower level. From these tanks the clear solution is pumped up to storage tanks, and is ready to be used again. If the precipitation is properly executed, the solution of sodium hyposulphite can be used for years without adding any of this chemical.

When all the soluble silver is extracted, the tailings are sluiced out through the central discharge, and the tank is ready for another charge of ore. The time required for silver leaching varies according to the character of the ore from 8 hours to two and three days. The calcium polysulphide which is used to precipitate the silver is manufactured at the works by boiling two parts of fresh lime with one part pulverized sulphur in water 3 or 4 hours. The boiling is done in deep boiler iron tanks into which steam is directly introduced. The consumption of sulphur is according to the ore, from 2 to 7 lbs. per ton of ore. The consumption of lime is about twice that amount. These are besides the salt the only chemicals consumed in this process.

When enough silver precipitates accumulated on the bottom of the precipitating tanks, the same is drawn off and strained through a filter press or through properly arranged filters made of cotton cloth. The precipitate is then charged into a small reverberatory furnace and the surplus burned off. The roasted precipitate is melted with lead in a cupelling furnace and refined. The wear and tear of a lixiviation plant is insignificant. The base-metal salts penetrating the wood of the vats prevent them from putrefaction and preserve them for many years.

One other system of lixiviation is the trough lixiviation. This system is a continuous one. The ore is fed mechanically first into a stream of water which rapidly moves in a triangular trough for the removal of the base-metal salts. The pulp drops into settling vats in which the washed ore accumulates. The washed ore is then sluiced out with a stream of sodium hyposulphite solution, and the pulp conveyed through a triangular trough to another set of settling tanks. In these tanks the mineral drops desilverized as tailings, while the silver is in solution. Base-metal salts and silver chloride dissolve almost instantly if the ore is charged into a rapid moving stream of the respective solvent. The chemical process of this method is the same as in tank lixiviation, but the time of leaching is enormously shortened, and the manipulations are much simpler and more labor saving. The method is especially adapted for larger works, and for ore which on account of lead requires a long leaching time.

We build all kinds of Lixiviation Mills and have drawings of many which we have built.

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THE COMBINATION PROCESS

FOR WORKING

Semi-Base Ore Containing Gold and Silver.

There is a class of Gold and Silver ores which cannot be economically worked in the Gold Mills of California or the Silver Mills of Nevada, but are being worked in a mill or combination of both these, at the Montana Company, Limited, Marysville, Montana.

The accompanying cut shows side elevation of this combination. The battery, copper plates, concentrators, completing the usual gold mill, the battery amalgamation and copper plates retaining all the free gold; and the concentrators all the sulphurets, there only remain in the tailings what gold and silver is retained in the gangue requiring further grinding to release it, and what is contained in the slimes, and escaped the concentrators. The further extraction of the values, which will be principally silver, will be effected by the use of grinding pans, settler, etc., the usual equipment for working tailings in a silver mill. By this combination the gold is extracted in its best form, **as amalgam**. The sulphurets which require roasting are freed from gangue and ready for the smelter or roaster, while the silver and gold in the tailings are extracted without the quicksilver being contaminated by the presence of the sulphurets taken out by the concentrators.

A further saving in the cost of pan grinding might be made by separating the slimes which do not require further grinding from the tailings as they come from the concentrators, and amalgamating them (the slimes) in barrels, the cost of which, the wear and tear, and the power required being largely in their favor.

Mr. John Darlington, Consulting Engineer of The Montana Mining Company, Limited, reported to the directors on September 17th, 1886.

The concentration of battery pulps before amalgamation, has been attended with most favorable results.

(1) The sulphides (obtained as concentrates) render the pulp fairly clean for the pans.

(2) The bullion instead of being low is brought to a high degree of fineness.

(3) It has led to very important and valuable saving of mercury in the pans; and in melting the crude bullion, to a material reduction in the weight of "granulations or metallic slag."

Mr. John Bayless, a director of the Company, in October, 1886, says:

"This system of amalgamation was adopted after a series of experiments and investigation during some months. It has been most successful, and one profitable result has been to increase the fineness of the bullion you produce from .550 fine as it was by the old process (raw amalgamation without concentration) to .930 to .950 fine as it is now."

"But this is not all, for the present process coupled with the praiseworthy efforts of your officers to economize in reducing the loss of quicksilver from 1.55 lbs. per ton to .8 lbs. in June and .62 lbs. in July. Now take the average of these two months—I will not assume we are always going to have July figures—it makes in round figures this difference, that for every ton of ore you treat the loss in quicksilver is ¾ lbs. as against more than 1½ lbs. by the old process, and this condition of things taking quicksilver at 50 cts. per pound represent £2,500 per annum."

In fitting up these combination mills, we recommend the use of the Johnston Concentrator which we are now manufacturing, and which after our long experience with other concentrators we can recommend as the simplest in construction, most durable, most easily managed, extracting the greatest percentage of and cleanest sulphurets. We make them in two sizes with 4½ foot and 6 foot belts. One of the smaller being sufficient to handle the pulp from an ordinary 5-stamp battery while the larger machine will concentrate for any 5-stamps. We will be happy to furnish catalogues and prices on application.

We recommend the use of canvas belt but furnish either rubber or canvas, and as our side rollers form the raised edge on the belt of our machine, the belt does not cost more than one-third as much as one with moulded edges which are the portions that first become useless.

In asking for particulars of combination mill, we will require to know the following particulars: Number of stamps and weight; power, steam or water; percentage of gold; percentage of silver; percentage of sulphurets; percentage of galena.

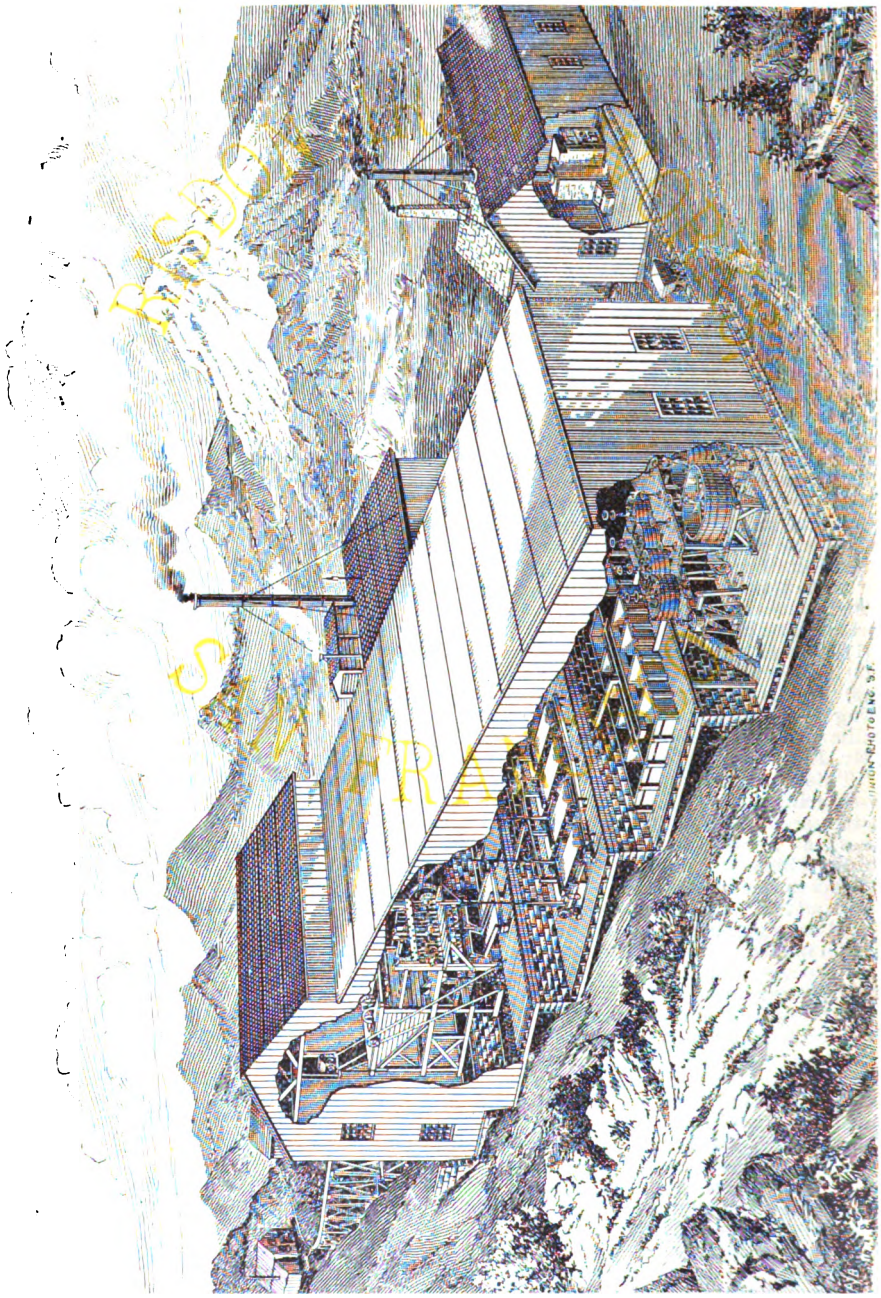
We also build combination mill, using the Bryan Mills instead of stamps. The cost of treatment of ores by the combination process as compared with treatment by roasting and chloridizing would be about as follows for a plant of 50 tons per day, value $25.00 per ton in gold and silver.

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COMBINATION PROCESS

FOR WORKING

Semi-Base Gold and Silver Ores.



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CHLORIDIZING, ROASTING AND AMALGAMATING.

Cost of 50 tons per day at $11 per ton		$550.00
Total assay value of 50 tons of ore	$1,250.00	
Less loss by volatilization, 5 per cent. in roasting before amalgamation	62.50	
	$1,187.50	
Less average loss in amalgamation, 12 per cent	142.50	
	$1,045.00	
Less cost of treatment	550.00	
Net result 50 tons		$495.00

Or $9.90 per ton net if $25 ore is received.

Cost of treatment of 50 tons of ore per day by

COMBINATION PROCESS.

Cost of treatment of 50 tons of ore per day by Combination Process at $3.50 per ton		$175.00
Gross value of 50 tons $25 ore	$1,250.00	
Less loss on treatment, 20 per cent	250.00	
	$1,000.00	
Less cost of treatment	175.00	
Total net results from 50 tons $25 ore		$825.00

Or $16.50 per ton from the Combination Process against $9.90 per ton from the chloridizing mill process, or $330 per day additional profit to a mine extracting and working 50 tons of ore per day.

In the above calculation, we have allowed a loss of 5 per cent. in volatilization from the chloridizing mill, which in practice is below the average, and if much gold is present the loss will be considerably greater from that cause.

We have allowed a loss of 12 per cent. in the process of amalgamating, which is below the average loss in amalgamating mills.

In calculating the loss in the treatment by the Combination Process, we have allowed 20 per cent. for loss in treatment. While this is greater than it should be from the process itself it must be remembered that a part of the product from the Combination Process is in the form of concentrations, and the excess in the estimate of loss is intended to cover the cost of treatment of the concentrations.

In comparing the value of the two methods of treatment, the difference in the cost of the plant necessary should be taken into account.

The average cost of erecting a forty-stamp dry crushing chloridizing mill is about $160,000, while the cost of a twenty-stamp mill for the Combination Process would, on the same basis, not exceed $65,000.

The above comparison is made of mills having the same capacity per day.

In the treatment of lower grade ores, the advantage in favor of the Combination Process is still more apparent, as ores containing by assay as low as $12 or $15, can be handled to a good profit, while the cost of the operation in a chloridizing mill would consume the entire value contents of these lower grade ores.

Heretofore we have made all our comparisons with treatment in a chloridizing mill; we will now attempt to show the advantage of mines erecting their own reduction works in place of selling their ores to the smelting works and ore buyers

As all the mines are differently situated, local circumstances govern the cost of freight to an ore market. We cannot make any table that will fit all situations, but will assume that on ores that are suitable for this method of treatment, the cost of freight to the ore market and the smelter charges will agregate $22 per ton. This will be rather below than above the average of such charges.

Net value of one ton of ore, if sold to smelter:

Assay value one ton of ore		$25.00
Freight and smelting charges	$22.00	
Sampling	1.00	
Freight paid on moisture	.50	
Smelter's deduction, 5 per cent	1.25	
Total deductions	$24.75	

This leaves practically nothing to cover the cost of mining and for profit: while on the basis of previous figures, it is shown that a ton of $25 ore can be made to yield $16 50 per ton after deduction of working charges and loss in treatment.

We will make two other comparisons. It will be shown by the first that $25 ore will yield as much profit treated on the spot by the Combination Process as $40 ore would if sold to smelters, where the smelting charges are as stated in the last comparison.

Net yield of $40 ore, where sold to smelters or ore buyers:

One ton ore, assay value		$40.00
Less freight and smelting charges	$22.00	
Less freight paid on moisture	.50	
Smelter deductions, 5 per cent. assay value	2.00	
Total deductions		$24.50
Leaving as net result from $40 sold to smelters		$15 50

Or $1 per ton less than $25 ore would yield if treated by the Combination Process

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THE

BRYAN ROLLER MILL

Is a modification of the well-known Chile mill, arranged for the continuous wet crushing of either gold or silver ores.

Plate No. 133 illustrates the construction of this mill, which consists of an annular mortar containing fixed segmental steel dies, arranged in the path of its three crushing rollers, which in the five-foot mill are forty-four inches diameter, seven inch face, and weigh 3650 pounds each, whose axles are fixed in them, and journalled in a central revolving table, attached to and driven by the overhead gear making a very direct application of power.

The four-foot mill has a similar arrangement of dies, but smaller rollers, weighing 1200 pounds each, exclusive of the gear.

The crushing weight of the rollers can be increased as desired by loading a tank.

These mills have an unusually large area of screen surface, permitting the free discharge of all pulverized ore, thus preventing the possibility of sliming.

They are excellent gold amalgamators, and save a larger percentage of gold than any other mill.

Many prefer these mills to stamps for the reason that they are portable, quickly and cheaply erected, require less power, and a less first cost than stamp mills.

They are built in two sizes, known as the four and five foot mills.

A set of wearing parts for a five-foot mill weigh 4460 pounds, and will crush from 4000 to 8000 tons of ore. A set of wearing parts of a four-foot mill weigh 2800 pounds, and will crush 1500 to 2000 tons of ore.

Size	Speed of Drum.	Capacity, Tons Per Day.	H. P.	Weight, Lbs.	Price.
5 feet	30 revolutions...	25 to 35	6	22,000	$2,450
4 feet.....	60 " ...	12 to 20	5	12,000	1,800
4 feet sectional	60 " ...	12 to 20	5	13,000	2,000

We manufacture complete gold and silver mills, in connection with these pulverizers as follows:

1st. Plain gold mills, steam or water power.

2d. Concentrating gold mills, steam or water power.

3d. Wet crushing silver mills, steam or water power.

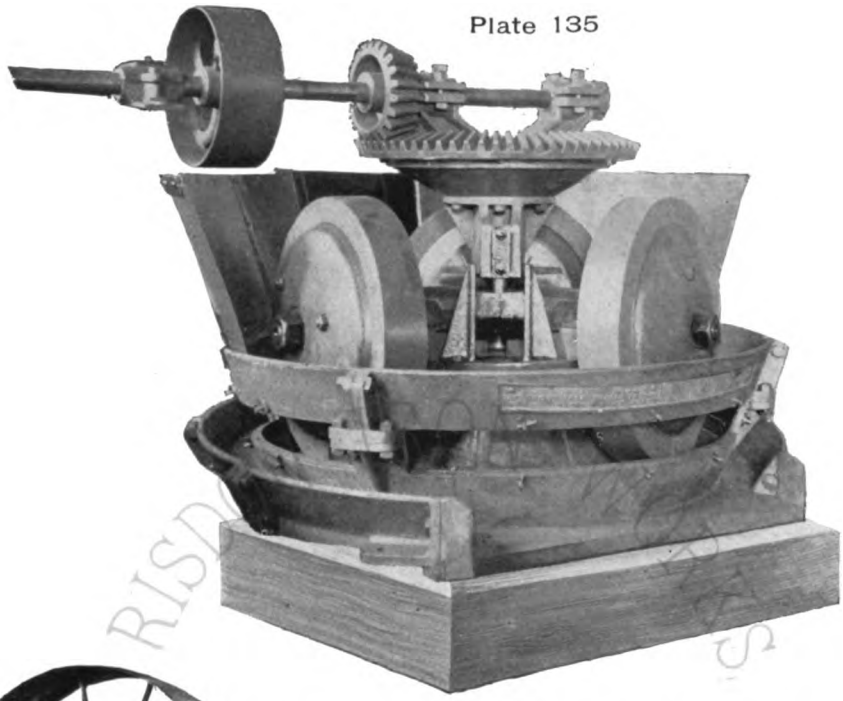
We build the four foot mill in sections, for packing over mountain trails.

Furnish plans and estimates, and quote prices for complete mills on application.

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FOUR FOOT BRYAN MILL.

Plate 135



FIVE FOOT BRYAN MILL.

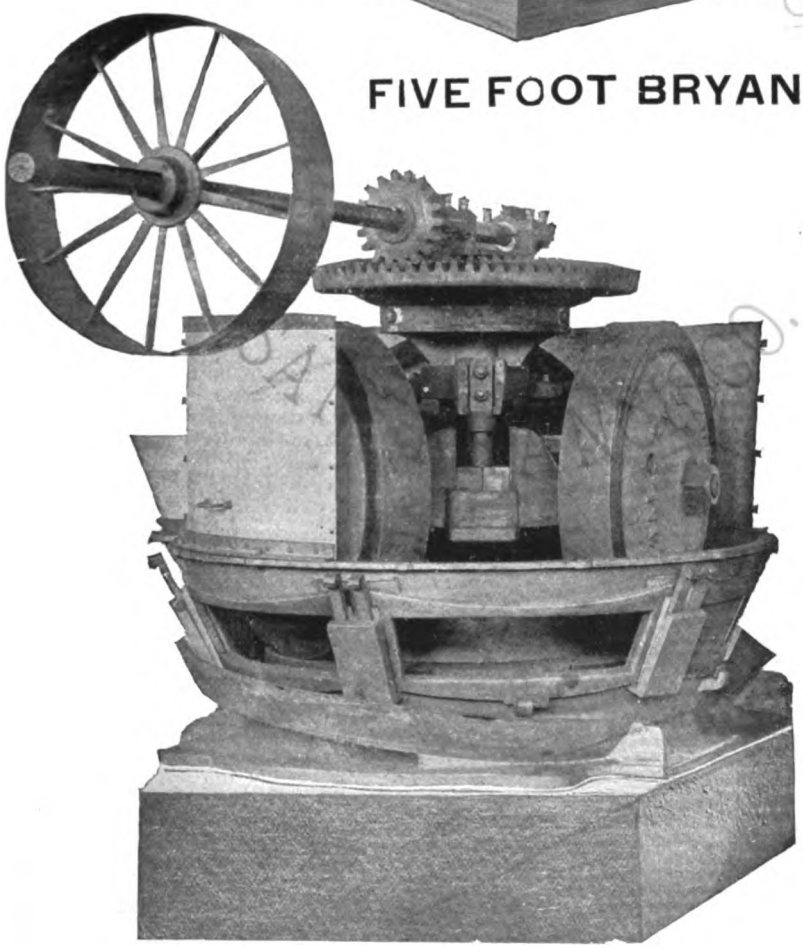


Plate 136.

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TESTIMONIALS.

Tepic, April 2, 1891.

RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO.

Gentlemen:—I take this opportunity to state that for the ores of the "Castellana" Mine your mill does excellent work; having also the great advantage for places situated at distances from workshops that can be attended to by persons not having much mechanical skill. I have recently ordered another mill for the San Sebastian Mines called "Jalisco," and I trust to observe the same favorable results from crushing those ores, which, however, are of a different nature.

Yours truly,

(Signed) ALFRED LONERGAN.

(FIVE YEARS LATER.)

Lonergan y Stanhope, Mexico,
Ixtlan del Rio, Tepic, Mexico, Sept. 16, 1896.

THE RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

Dear Sirs:—On my arrival here yesterday I found your favor dated 28th ult., and have pleasure in replying thereto. In the Castellana Mines, two No. 4 sectional Bryan Mills are working and have been working for over five years. In the Jalisco Mining Company's Mill at San Sebastian, two mills of same dimensions are likewise at work. All obtained from your works.

I am able to state that these have given complete satisfaction, crushing through a forty-mesh screen on an average of from ten to eleven tons in twenty-four hours, and through a sixty-mesh screen from nine to ten tons in twenty-four hours.

The principal attraction these mills have is the great facility for keeping them in repair in places where skilled mechanical labor is extremely scarce, as is the case in the mining districts of these parts of Mexico.

You are perfectly at liberty to insert all or any part of this letter as a testimonial to any of your customers.

Yours very truly,

(Signed) ALFRED LONERGAN.

Baker City, Oregon, March 22, 1891.

RISDON IRON WORKS, SAN FRANCISCO, CAL.

Dear Sirs:—The five-foot Bryan Mill you furnished for the Elkhorn Mining Company, in 1890, has been running regularly, and has given excellent satisfaction.

As an amalgamator of gold the Bryan Mill has no equal. It has really astonished those who have seen its work. It has saved more gold from our heavy sulphureted ore than I had believed it possible, and more than any other mill can save.

ELKHORN MINING COMPANY,
J. H. ROBBINS, President.

(FIVE YEARS LATER.)

McCoy, Oregon, September 1, 1896.

RISDON IRON AND LOCOMOTIVE WORKS.

Gentlemen:—The five-foot Bryan Mill you shipped us five years ago has given us the best satisfaction as a pulverizer and amalgamator. I do not think it can be beat. It makes no slimes, and will free the gold in base ore to so great an extent that it will amalgamate.

I am aware that many people are prejudiced in favor of stamps; but the Bryan Mill, properly managed, is better than stamps or any other quartz mill that ever was invented.

Respectfully, ELKHORN MINING COMPANY,

(Signed) J. H. ROBBINS, President.

Little Kid Mine, Norris, Montana, October 9, 1896.

THE RISDON IRON WORKS, SAN FRANCISCO.

Gentlemen:—I take pleasure in informing you that the five-foot concentrating Bryan Mill plant erected at the Little Kid Mine for me last year has given entire satisfaction. Both the Bryan mills and Johnston concentrators are all that you represent them, and I am more than pleased with the results obtained, and have no hesitancy in recommending your mills.

Yours truly, JOHN MCKELVY.

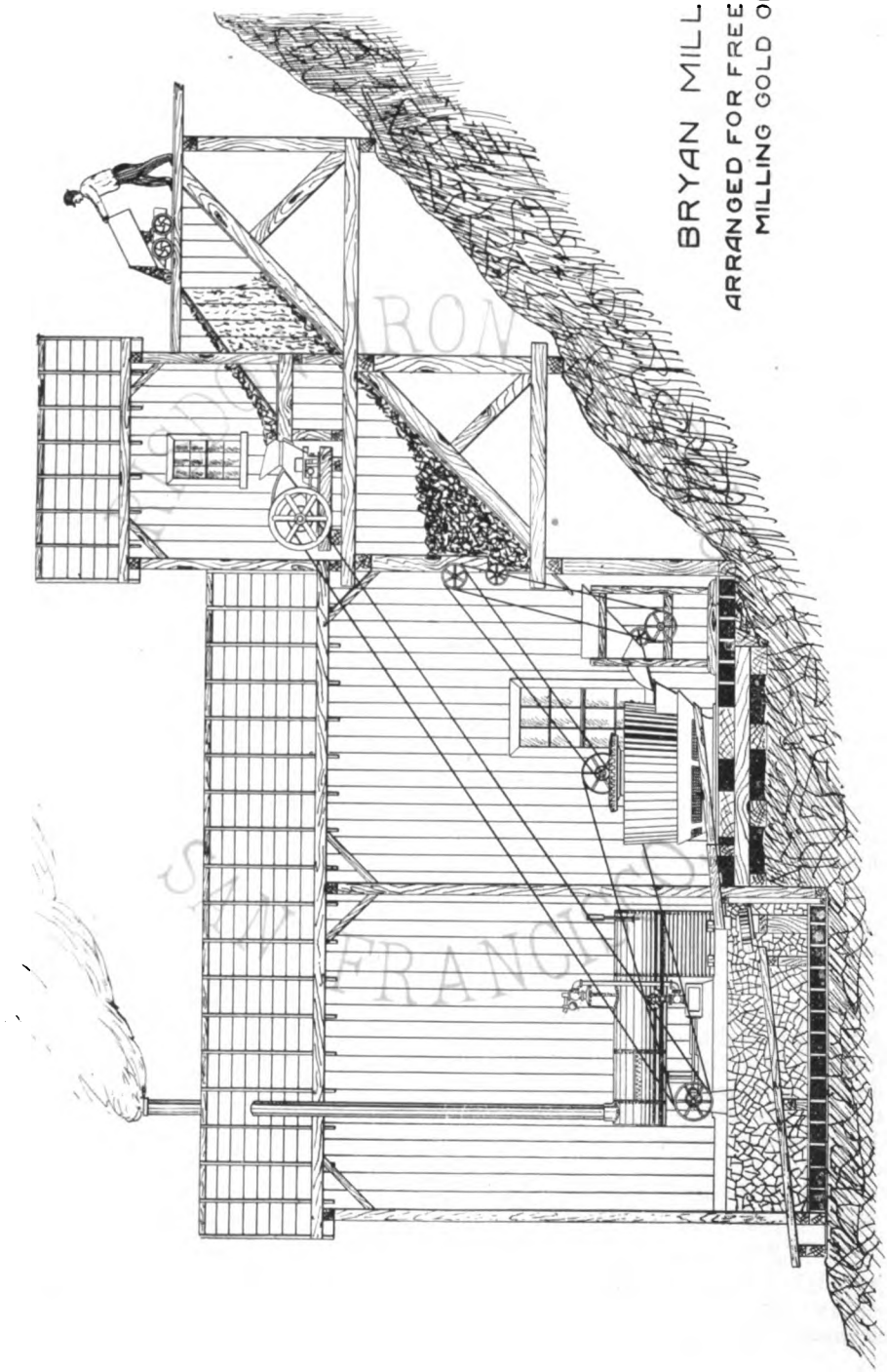
[Extract from letter from Professor J. H. Kerr, York, Montana, Old Amber Reduction Works, dated March 10, 1896]:

"We have started up our Bryan Mill plant and take pleasure in informing you that it is running fully up to my expectations. We have seen your mills in operation in Mexico several years ago; and, at that time, I made up my mind that they were the most economical mills for crushing ore I know of.

"Your mills here are crushing about thirty-five tons per day through a forty-mesh screen and giving every satisfaction.

"The Johnston Concentrators are doing excellent work, and I take pleasure in recommending them."

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BRYAN MILL
ARRANGED FOR FREE
MILLING GOLD ORES

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The Bryan Mills have passed the experimental stage and are now in successful operation on the Pacific Coast, in Virginia, Georgia, Mexico, Tasmania and Australia.

A large number of testimonals have been received from the users of these Mills setting forth their many advantages. Among the advantages we name are:

1.— Its large screen capacity and free discharge.

2.— It amalgamates a larger percentage of gold.

3.— Its foundations are simple and cheap.

4.— It is quickly and cheaply erected.

5.— It requires a minimum of power.

6.— It is comparatively noiseless.

7.— It crushes hard as well as soft ore.

8.— Its slow speed prevents the extraordinary wear and tear of high speed Machines.

9.— *As a gold amalgamator, it is superior to all other Mills*, not excepting Stamps.

The amalgam can be seen in the mill while in motion, as it collects around the central cone (where the motion of the pulp is the least) as fast as it is liberated from the matrix, and consequently is not subjected to regrinding and flouring of quicksilver.

We do not recommend them for dry crushing.

The axles are fixed solid in the rollers and are journaled on an annular plate, which rotates loosely around the solid center post, and all the bearings are thoroughly lubricated by oil channels, so arranged as to absolutely prevent the oil from entering the mortar.

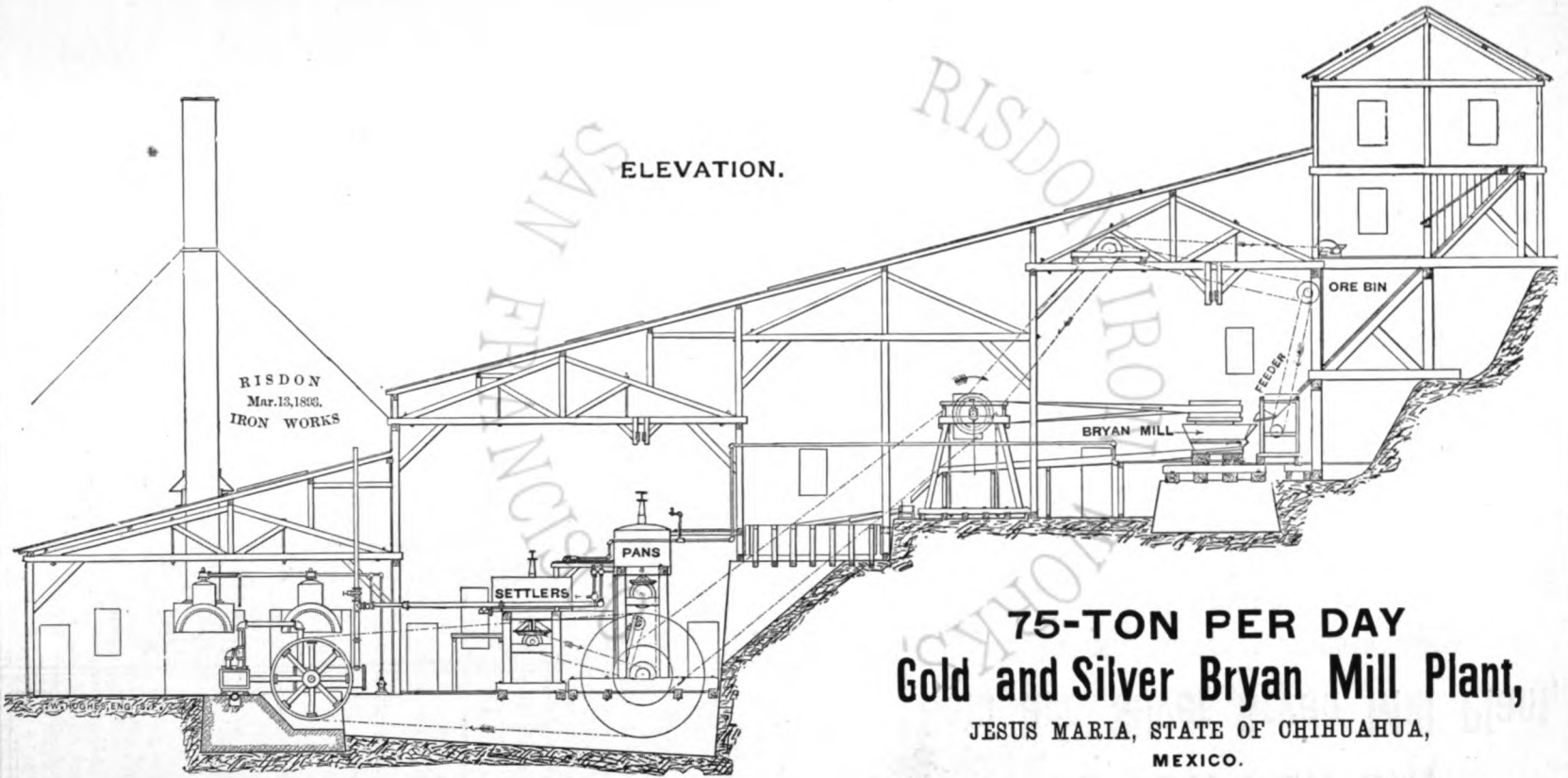
A very important feature of the Bryan Mill is the device for keeping the rollers clean from pulp. It consists of an Adjustable Spring and Scraper, shown very clearly in the engraving, which follows each roller in its rotation. The spring is set to the die and its tension is readily adjusted. The direct purpose of the scraper is to keep the face of the die, and the roller also, clean from pulp, which otherwise would collect and adhere to the rollers and pack on the dies and reduce its crushing force. The scrapers serve also to discharge the pulp, and to equalize on the dies the ore received from the feeder.

The mortar is provided with screen openings all the way around, thereby giving ample surface for discharge. The chute for carrying off the pulp extends all around the mortar to the spout over the apron.

In the operation of the Mill the pulp runs around the mortar next to the screens in a rapid current of not less than 300 feet per minute; but toward the center, inside of the rollers, the movement of the pulp is much slower, and as the gold is liberated from the matrix, it falls to the eddy side of the current, and in practice is found amalgamated in mass around the cone in the center of the mortar. By this action the free gold is not subjected to the continuous grinding of the rollers in the mass of pulp, and nearly all the gold contained in the ore, fully 80 per cent, is retained in the mortar. The ore does not slime, and the sand and pyrites are left of uniform size and in the best condition for concentrating. The "clean-up" of the Mill, owing to its simple arrangement, is done with the greatest ease.

The Mill is made of the best quality of iron and specially selected steel, and is thoroughly finished in all its parts. The mortar, with the chute and spout, is generally cast in one solid piece, but for transportation by packing in the mountains the mortar is specially cast in sections weighing 300 pounds.

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75-TON PER DAY

Gold and Silver Bryan Mill Plant,

JESUS MARIA, STATE OF CHIHUAHUA,
MEXICO.

RISDON IRON WORKS SAN FRANCISCO

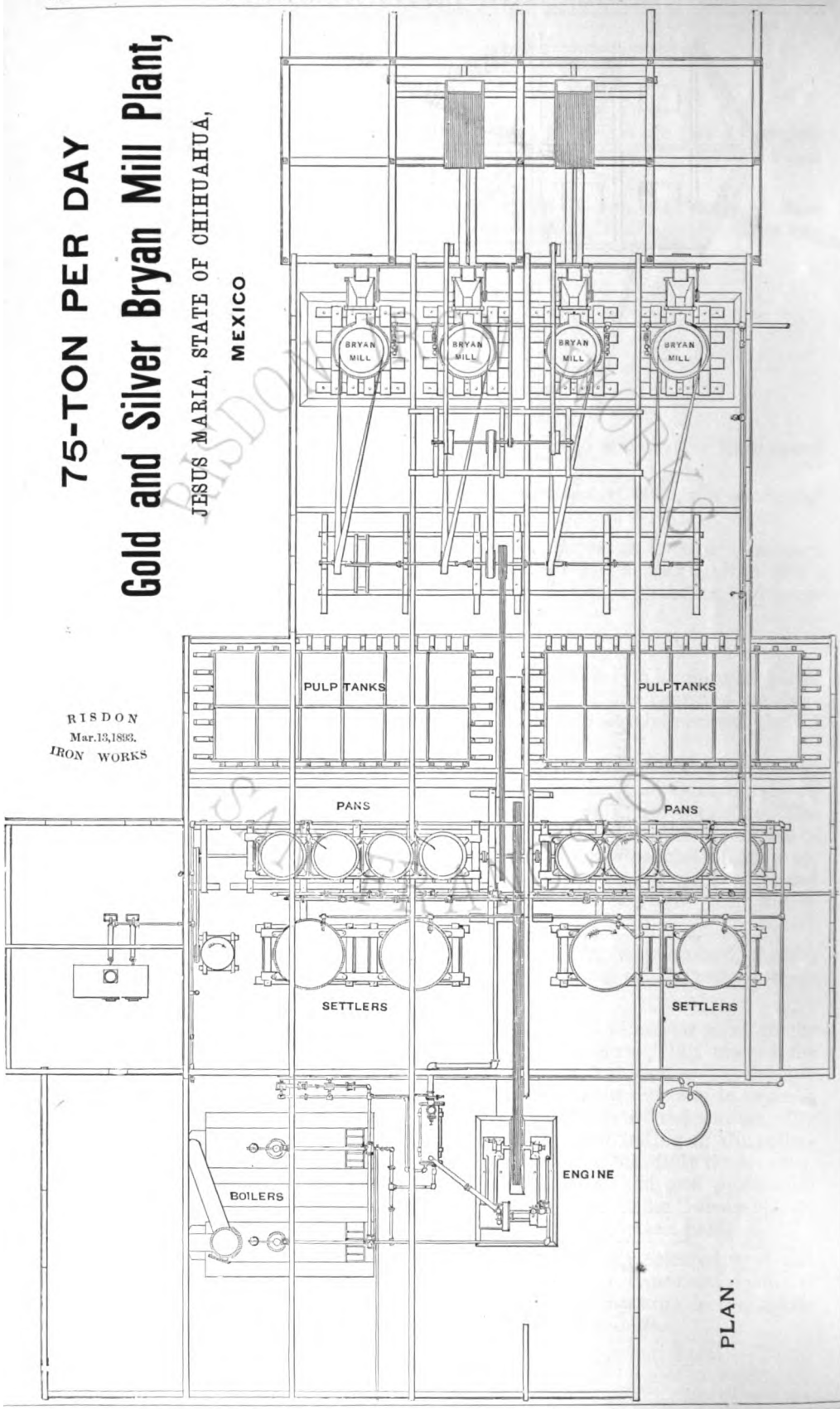
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JOHNSTON

75-TON PER DAY
Gold and Silver Bryan Mill Plant,

JESUS MARIA, STATE OF CHIHUAHUA,
MEXICO



RISDON
Mar. 13, 1883.
IRON WORKS

PLAN.

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HISTORY OF THE PATIO PROCESS.

The Patio process for reducing ore was invented or discovered by Bartholeme Medina, a native of the town of Pachuca, in Mexico, in 1557. It is still practiced and used extensively in that country and South America in all its primitive simplicity, and when we take into consideration the very cheap labor, the almost total absence of fuel and the great scarcity of water in many of the mining districts, we can well see why it has not been superseded by other methods.

Medina himself was no chemist, but the modifications made later on by scientific men have shown the process to be one of the greatest importance, and that the accidental invention of this process has proven a great source of profit to the Republic of Mexico there can be no room for doubt. These modifications introduced upon Medina's method were, not only in a mechanical, but also in a chemical way, part of the process. The use of the pure chloride of sodium would never probably have been adopted had not the scientists suggested it, as in early Patio days a combination of sulphate of copper with water was considered indispensable for the reduction of many ores.

Many attempts have been made by various engineers to do away with the manual and animal power used now in this process, but all attempts have been more or less fruitless except as specified later. Moreover, the improvements which have been made apply to the grinding of the ore and the preparing of it for reduction by the Patio process and not to the mixing and stirring of the ores.

At various times experiments have been made by foreign companies and engineers to replace the Mexican Arrastras by the American Stamp Mills, known in Germany hundreds of years ago, but greatly improved within the last fifty years. Some of these experiments have been successes, and others failures. On certain ores, however, the iron from the stamps works into the pulp and retards the extraction of silver from the ore, while on other ores this addition of iron proves an advantage.

The oldest system of grinding ores for the Patio process is the one that is now still used in many places in Mexico, Peru and Chili. The ore is first brought to the hacienda and crushed by a primitive, ill-constructed Chilian Mill, this being made entirely of wood or stone, and being propelled by mules or horses. The great defect experienced with these has been that the cylinders revolving upon the bed plate wear out quickly, necessitating many stoppages, and therefore causing an additional expense in the grinding of the ore. The first improvement introduced was the use of cast iron tires on the outside of the stone wheels, the tires being fastened to the wheels by wooden wedges; this system has been in use until late years, when improvements have been made in the manufacture of steel tires, and rings of this kind have been experimented upon in the haciendas of Pachuca and Guanajuato. These tires are of a very homogeneous metal, and wear very equally. They last from four to ten times as long as cast iron rings.

Next it was found that the bottoms of the Chilian Mills did not wear as long as the revolving wheels, and first cast iron and then forged steel plates were put in to protect the foundation stones. Later on the whole of these mills was made in iron, and these are the mills that are now in use in the largest haciendas. (Our Bryan Mill is the latest improvement in Chilian Mills, and particulars can be found on page 84.)

THE PATIO PROCESS.

The ore on being taken from the mine is given to the sorters—men, women and children, all working—who break the ore into small pieces, and with great skill select what experience teaches them is rich enough for smelting, throwing aside the waste or what is supposed to be too poor for treatment; the remainder is the second-class ore, which is to be crushed and pulverized by the Arrastra or Chilian Mill, with a view to its future treatment by amalgamation by the Patio process.

This ore is first crushed by a primitive stamp mill, which is run by mule power. As a rule the stamps are made of wood and shod with iron, and will weigh from one hundred pounds to two hundred pounds each, and in most cases have flat stones for mortars. This reduces the ore to a fineness of wheat, or, in some cases, the size of corn, depending upon the character of the ore. The pulp is then taken from the mill and placed in the Arrastra or Chilian Mill, where it is ground into a perfect slime or mud. Of these two methods the more popular is

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THE ARRASTRA.

The Arrastra, of which Plates 240 and 241 are illustrations, is commonly worked by mules, which turn a vertical shaft, from which one, two or four cross-bars or arms project far enough beyond the circle of the mill to hook on one or two animals, as may be desired. Some small Arrastras will have only one animal, while the larger ones will have as many as six.

The construction of this crushing mill is very simple. A suitable place is selected where the soil is very firm. The top soil is taken off and a circular excavation made deep enough to get a clear, solid foundation. Flat stones from six to eight inches thick are then placed on end around the circle and project above the ground a foot or more, making a complete circle of upright stones placed as closely together as possible and filled in behind with closely packed mud or cement. A large pyramidal stone is then placed in the center of the circle with a drill-hole in its apex. Around this central piece flat stones from six to eight inches in thickness are laid on the ground and the cracks filled in carefully, thus paving the bottom as well as the sides with stone and mud. An upright spindle is then provided with a gudgeon on each end and notches or openings made at the proper distances for inserting the driving arms. Two posts are then set firmly in the ground directly opposite each other and in a line with the center of the mill. These posts are far enough from the outside of circle of mill to allow the animals attached to the sweep or arm to pass between. From the top of these posts a cross-beam is placed, in the center of which is an aperture to receive one end of the upright spindle, the lower end of which fits into the center stone. The sweeps are then fixed into the upright and the Arrastra is ready to receive the crushing stones or drags. For this purpose any heavy, hard stone, with one flat surface, is secured, a hole is drilled into it, and a piece of chain or rope fastened in by driving in a wooden plug. The ropes are then fastened to the sweeps or arms at the proper distances to cover the entire bottom of the mill as they are drawn around by the animals. A little refuse mud and gravel is thrown in with enough water to make it soft. The mules are started on their circular walk and the drag stones are soon smooth on the bottom, the cracks are all filled up solidly, and the Arrastra is ready for business. A charge of ore is then put into it, a little at a time, with the proper amount of water, until it has a full charge. It is then ground until fine enough, and, if silver ore is under treatment, a small amount of coarse ore is added from time to time, and the mud or slime drawn off from the top, where it is settled, and made ready for the Patio. If gold ore is under treatment, quicksilver is added to the pulp and amalgamation takes place in the Arrastra, and for free ores it is conceded by all that no better amalgamator is known.

The amount of ore crushed by this old-time process will depend largely upon the size of the Arrastra, the number of mules used and the condition and character of the ore;as a general proposition from 300 pounds in a one-horse mill to 1,300 pounds in a four horse mill.

Often instead of crushing in the Arrastra the ore is crushed in the Chilian Mill—the choice of these methods depending, to a certain extent, on the nature of the ore, and on the permissible first cost of the plant, the first cost being greater in the case of

THE CHILIAN MILL.

The original Chilian Mill was built in the same manner as the Arrastra, with the same circle of stones and heavy stone pavement inside, but in place of the stone drags a large stone wheel was fitted on the sweep, and as the animal moved the wheel revolved, crushing the ore much more rapidly than the Arrastra. These Chilian Mills are more costly than the Arrastras, but they have recently been greatly improved, and are coming more largely into use. We built one of these improved mills once. It has been familiarly known as the Bryan Roller Mill, and a full description will be found on page 84. After the ore is properly crushed we reach the stage of the Patio.

THE PATIO,

The pulverized pulp when taken from the Chilian Mill or Arrastra, is in the shape of a thin, slimy mud, and is placed in vats or open spaces on the ground where a large part of the water is evaporated by the heat of the sun, and is then ready for the Patio.

The Patio or Amalgamating Floor, is a large open space with a slight incline to allow the water to run off. In this open space are a number of circular spaces, from twenty to forty feet in diameter, surrounded with frames of wood or low walls of stone. (Sometimes the openings or walks between the Patios are paved with small stones.)

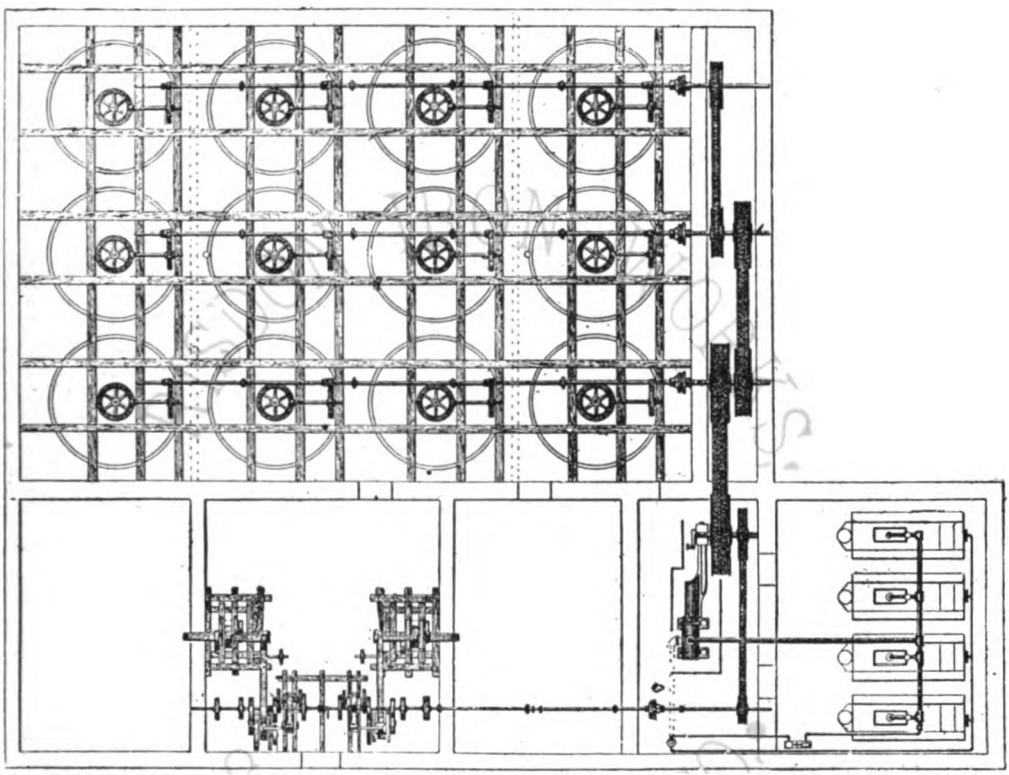
To these spaces the pulp or "lama" is removed and a certain charge deposited. This is called a "torta," and may weigh fifty, or as much as one hundred tons, and will form a layer of soft mud from six inches to one foot thick. This is allowed to dry in the sun until the operator is satisfied as to its condition. A small percentage of salt is then added, according to the character of the ore under treatment, and the mules or other animals are then driven over it, treading the pulp and mixing it thoroughly. It is then allowed to rest for a day, sometimes several days, when magistral and mercury are added. Magistral is prepared by mixing roasted copper pyrites, iron pyrites and a small quantity of salt. The amount of mercury and other chemicals used in a torta or charge is fixed by the value and character of the ore under treatment. The time in which a torta may be worked off will vary from fifteen to forty-five days, according to the season of the year, as much depends on the natural heat of the sun.

When the tests of assays show the operator that the torta is in a proper condition and amalgamation has taken place, the treading by animals ceases and the torta is finished.

The next operation is to wash the whole mass and separate the amalgam. This is done in several very simple ways and a very high percentage is saved.

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IMPROVED ARRASTRA MACHINERY.



The Arrastra plants that we have constructed in late years are from eighteen to twenty-one feet diameter, the bottom being paved with stones about 10x10 inches square, made of the best kind of granite and set vertically to a depth of about three feet. The outside of the Arrastra is constructed as formerly—namely, by erecting flat stones projecting from eighteen to thirty inches above the floor of the Arrastra. The dragging stones, which are usually made of granite, and which weigh in our latest design from 11,000 to 25,000 pounds, are dragged around on poles or arms. Our plan is to connect all the Arrastras to one or two principal line shafts and provide each Arrastra with a clutch to allow throwing it out of gear, should it be necessary, without stopping the shaft.

For motive power we have been using our Corliss Engines and we have found that by this method we can pulverize the ores at less than one-half the cost of the old Arrastra system.

Cut shows ground plan of such a plant.

The Power consists of one of our 12x36 Corliss Engines and two Steel Boilers, with pump and fixtures complete.

The primary crushing plant consists of one 8x12 Dodge Rock Crusher; two 24x14 Belt Crushing Rollers.

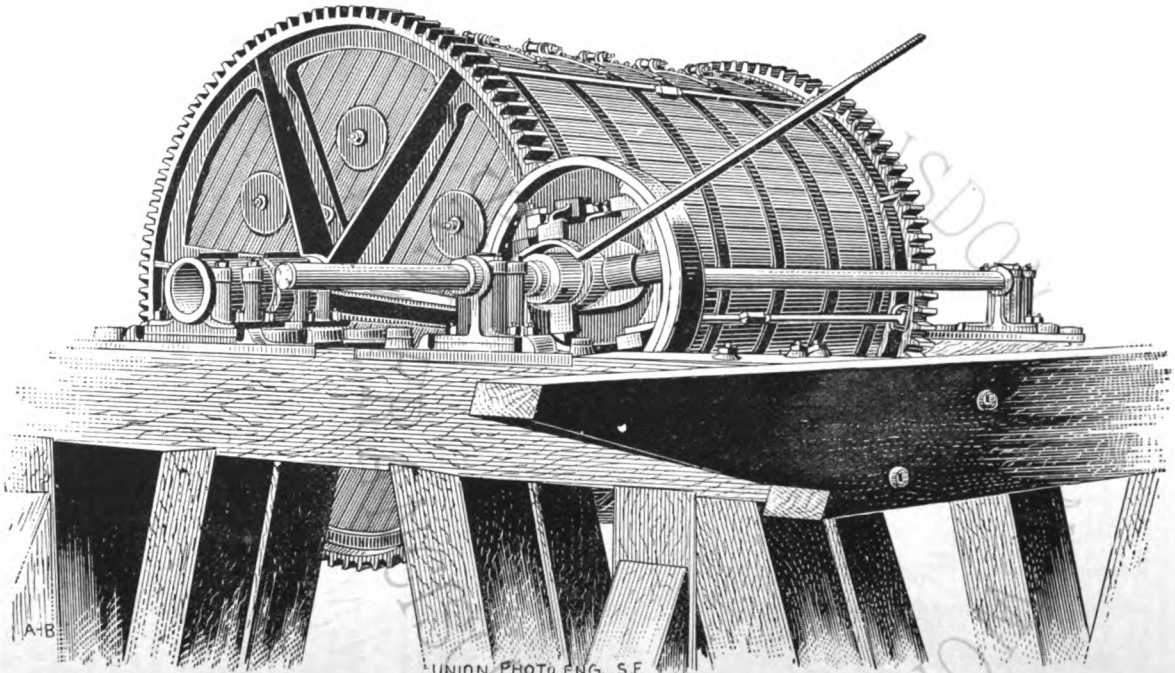
The ore is first fed to the crusher, from where it drops automatically into the rolls and revolving screens, where all the pulp that has not been ground fine enough is separated by screening, and sent back to the rolls by elevators all working automatically. The pulp, when fine enough, is taken to the Arrastra for final treatment.

The crushing capacity will vary according to the character of the ore ranging from six to ten tons in each 12-foot Arrastra every twenty-four hours.

This machine is specially adapted for working Cement Gravel or Gravel carrying rusty gold which will not take quicksilver until polished or ground.

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IMPROVED AMALGAMATING BARRELS.



These barrels are seventy-two inches in diameter by eighty-four inches long. These dimensions are inside and do not cover the gearing or the shafting of the outside. The amalgamating is done altogether in these barrels, in the same manner as it is done in amalgamating pans, except there is no grinding action whatever, and, consequently, no metallic iron is mixed with the ore, which some companies claim is objectionable with their ores.

The barrel is made of wood staves three inches thick, and the heads are also lined with wood three inches thick; every bolt head that penetrates the wood is carefully sunk into the wood and covered over so that no action of the chemical that is mixed with the iron can touch any iron work. The barrel is revolved about ten times per minute. After revolving in this barrel as long as is considered necessary for the ore, it is then discharged from the barrel into settlers and the quicksilver is settled in the usual way, as is done in the Patio process and the amalgamating mill. The barrel is arranged with friction clutch so that it can be stopped at any time without stopping the main engine.

Above each barrel is a feed hopper that holds just the charge of the barrel; this is filled, ready, so that when a charge is emptied another is put in

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CONCENTRATING MACHINERY

When ores containing tellurides of gold and silver, gray copper, iron and copper pyrites, argentiferous galena, zinc blende, brittle silver, ruby silver, and native silver, are too low grade to be worked profitably at the mine as a whole, fine concentration is employed.

This process concentrates the values of the ores, and rejects the worthless gangue. To accomplish this object the ore is crushed in a battery (where any free gold may be saved) the pulp is then concentrated on Vanners or concentrators of various types, the product is known as "concentrates," and contains from 90 to 99 per cent of the total value of the ores concentrated.

It frequently happens that 100 tons of ore are concentrated into from five to ten tons of "concentrate."

These concentrates are now so valuable as to permit of their transportation to reduction works, or of their profitable treatment at the mine, when the quantity is sufficient to justify the erection of works for that purpose. The cost of crushing and concentrating as described (using steam-power and wood fuel at $4.00 per cord) is from 50 to 75 cents per ton of ore, with water-power 40 to 50 cents per ton, in mills of 50 tons capacity, and upward.

When the ores to be treated contain lead, zinc, copper, and iron in large crystals, in seams, or in masses, so that when broken in comparatively large pieces a fairly good separation can be effected between the valuable mineral and waste rock, coarse concentration is sometimes employed, in the following manner. The ore is passed through the Rock-Breaker and then through crushing Rolls.

From the Rolls the crushed ore passes through a series of revolving sizing screens, as follows: The ore passes from the coarse Rolls into the coarsest revolving screen, sometimes called "trommel." All ore too coarse to pass through the perforations of this screen falls from it and is conveyed by a suitable conduit to the finishing Rolls. After going through these it is elevated, and again passes into the first screen and no ore too coarse to pass through the meshes of this screen is allowed to proceed to the concentrating machinery. All particles passed through perforations of screen No. 1, are delivered to screen No. 2, which has finer perforations, and in like manner from screen No. 2, and through screens No. 3, No. 4, and No. 5: Each of these screens delivers its contents continuously to its jig below.

The jigs separate the heavy parts from the lighter waste.

The mineral portion is now comparatively pure and of greatly increased value per ton, permitting of practically the same course of treatment as the concentrates from fine concentration.

"Coarse" concentration when practiced on a large scale is somewhat cheaper than "fine," but does not give as close results, hence this system must be charged with an excessive loss of metals, and credited with the economy of its work.

Trommels and revolving or sizing screens are elsewhere described in this catalogue.

Prices for fine and coarse concentrating machinery quoted on application. Plans furnished with machinery.

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Coarse Concentration.

RISDON IRON WORKS,
SAN FRANCISCO,
CALIFORNIA.

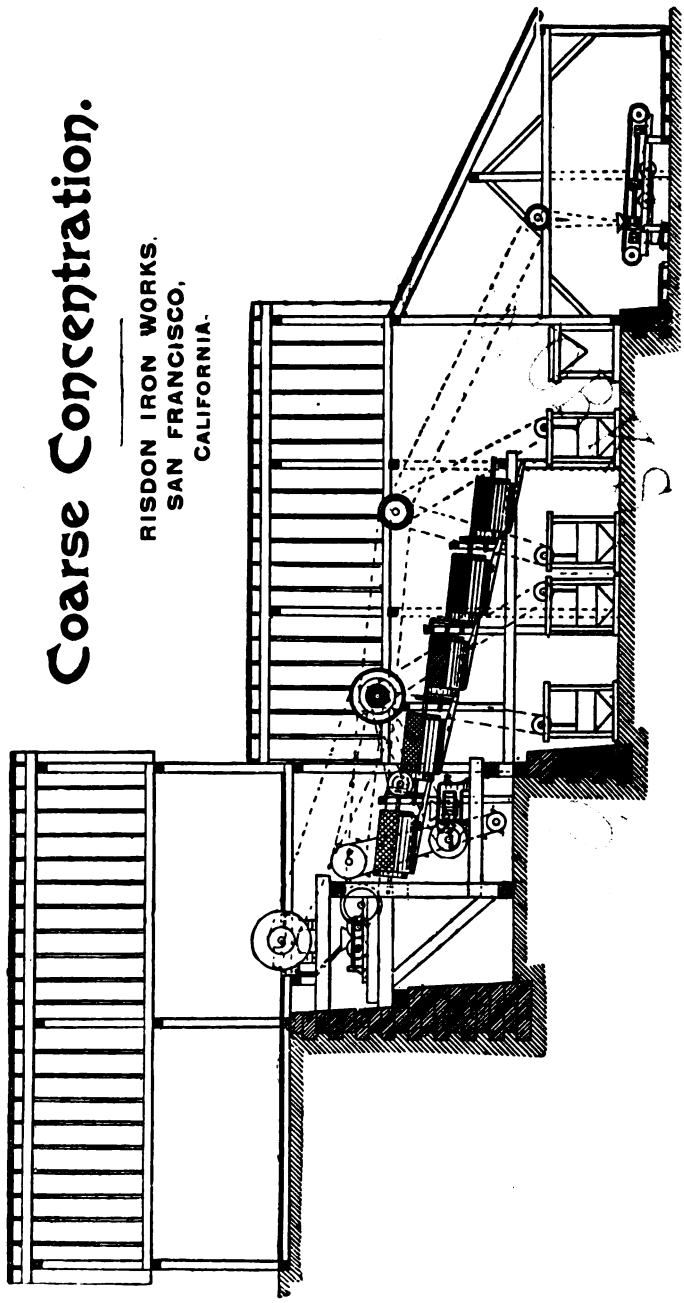


PLATE A.

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Concentration Mill Complete.

We have many plans of Concentration Mills of varying size and differing somewhat in general arrangement.

Plate A, Page 92, will give a general idea of the arrangement of a small mill for coarse concentration, with machines for fine concentration of tailings. The top floor is an ore floor on which rock is delivered to mill. Below this floor are placed in succession rock breaker, coarse rolls and finishing rolls. The ore after passing through breaker, drops at once to coarse rolls and from them into the coarsest revolving screen or trommel of a set of five. All ore too coarse to pass through the perforations of this screen falls from it by a spout to the finishing rolls, after passing which it is raised by the elevator and again passes into the first screen. It will be seen, therefore, that all ore has to pass the perforations of this screen before it proceeds to the concentration machinery.

All ore particles which pass the perforations of screen No. 1 are delivered by the trough and inclined spout surrounding its lower part into screen No. 2 of finer perforations. The particles which pass through holes of No. 2 are delivered into still finer screen No. 3, and so to finest screen No. 5. The particles of ore which remain on these four screens are of regular size, *i. e.*, smaller than the holes of the preceding screen and larger than the holes of the screen they remain on. The four screens discharge their contents continuously to the four jigs placed below.

The jigs separate the heavy mineral particles, from the light waste particles of rock. The screening is usually done wet, with jets of water washing the screens to keep them clear.

The material too fine to be caught on the last and finest revolving screen, either flows into large pointed settling tanks to be rid of the excess of water (the thickened pulp being drawn off below to the slime dressing machine), or it is run over hydraulic classifiers, in which an upward stream of water produces a more perfect sizing than mere settling boxes.

The slime dressing machinery is either revolving buddles, Johnston Concentrator, ordinary buddles, or Rittinger tables, as preferred, or as ore may require.

We sometimes put in two rock breakers: one to crush directly from the other to prepare the rock in large quantities for the rollers, and relieving the latter.

Plate B, represents a very complete Concentrating Mill for coarse concentration, having in addition to the machinery described in Plate **A**, a stamp battery for re-crushing tailings from jigs which must be pulverized finer to liberate the mineral particles. For some ores this is found necessary, small particles of mineral being carried by pieces of rock several times the volume of the mineral in size, but so small and light that they have been carried past the previous saving devices. After crushing so fine in the stamp mill **or Bryan Roller Quartz Mill,** very delicate treatment is necessary, and is best accomplished by the Johnston Concentrator, but has been done by Buddles and Rittinger tables.

Plate C, represents a plan of mill adopted where there is no bank or hillside to build against, and all elevations must be obtained in the building itself by timbers.

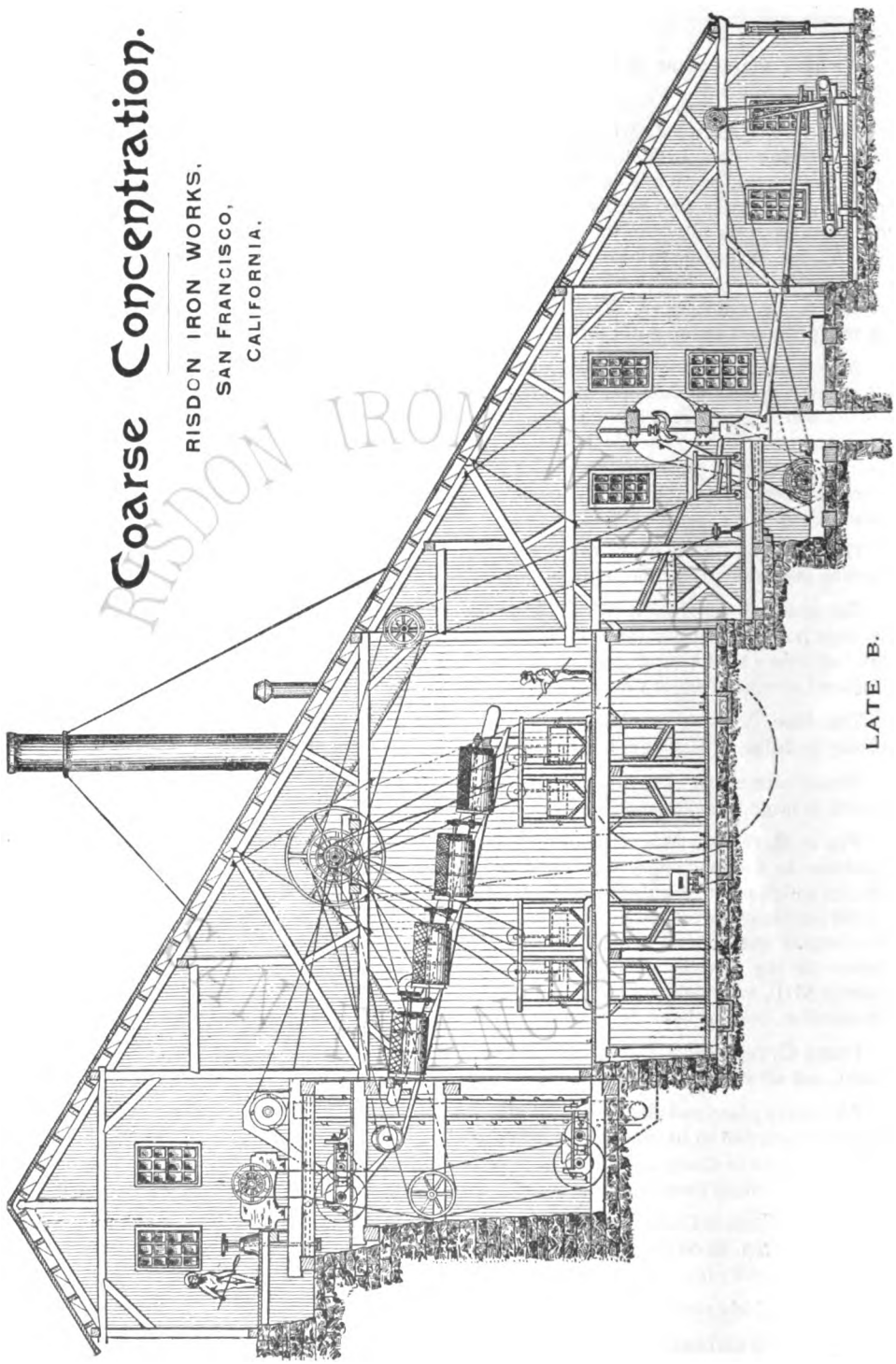
We supply plans and detailed drawings for erection of the building of all mills when the contract is awarded to us, and gladly work under the direction of engineers and millmen who have such works in charge, and to whom we offer the assistance in designing, or reference in our draughting department to our great variety of drawings of all kinds of mills and machinery.

We make Coarse Concentrating Mills of 15 to 100 tons capacity and over, having furnished the **Anaconda Works** in Montana, with its fine equipment. Fine Concentration Works are built of capacity from five tons daily upward.

We particularly recommend the **Bryan Roller Quartz Mill** for re crushing tailings.

Water required.—The quantity of water required per ton of ore treated is 4,000 gallons, but can, if necessary, be returned and used over with a loss of about 20 to 30 per cent., depending upon the character of the ore, ores having clay in the gangue requiring more water than those in which the gangue is clean hard rock. When steam power is used about one cubic foot per horse power per hour is consumed by the engine.

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CONCENTRATION MILL.

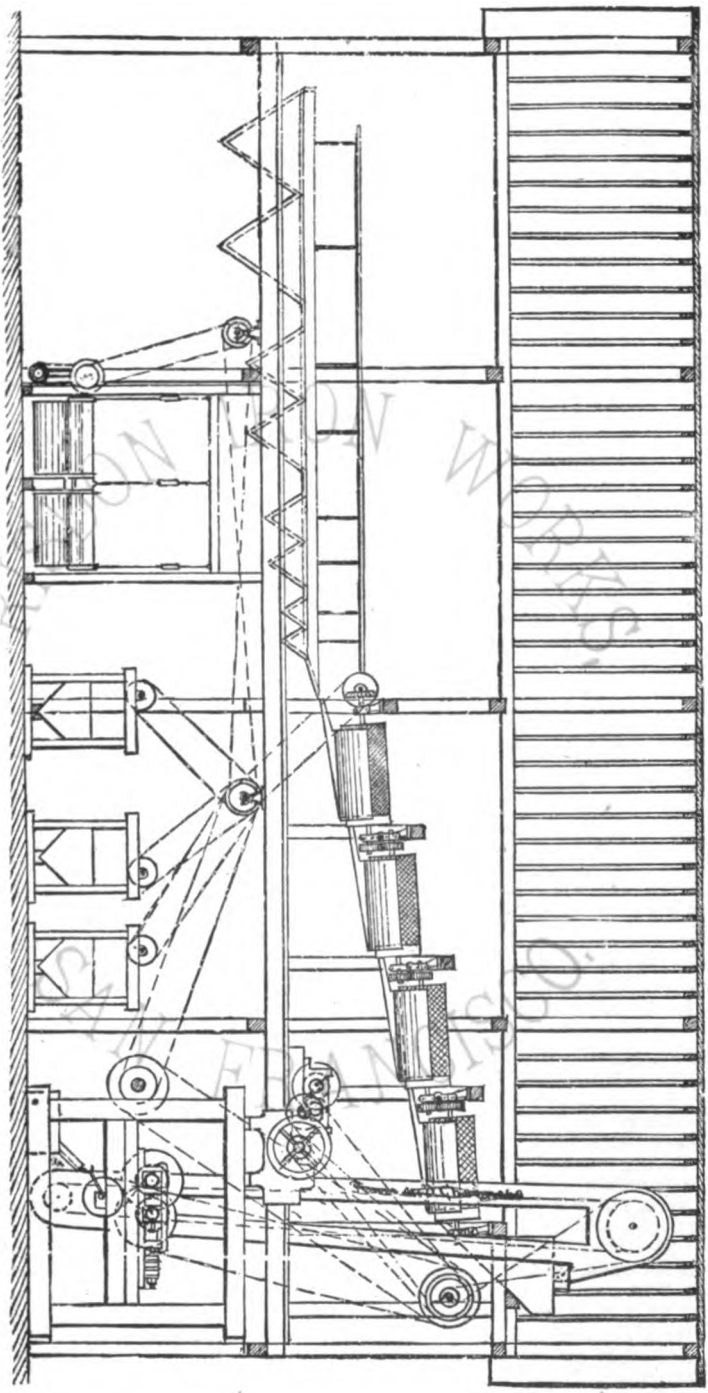


PLATE C.

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PLAN OF CONCENTRATION MILL.

Plate No. E represents a concentrating mill of a capacity of from 100 to 125 tons per day of twenty-four hours depending upon the character of the ore. In this mill the ore is first dumped upon inclined grizzleys, which separate all pieces small enough for crushing, the coarser productions being passed through a 15x9 Blake Crusher, which discharges into the same bin as the grizzley. From this bin the ore is fed, by means of a chute, directly into the stamps.

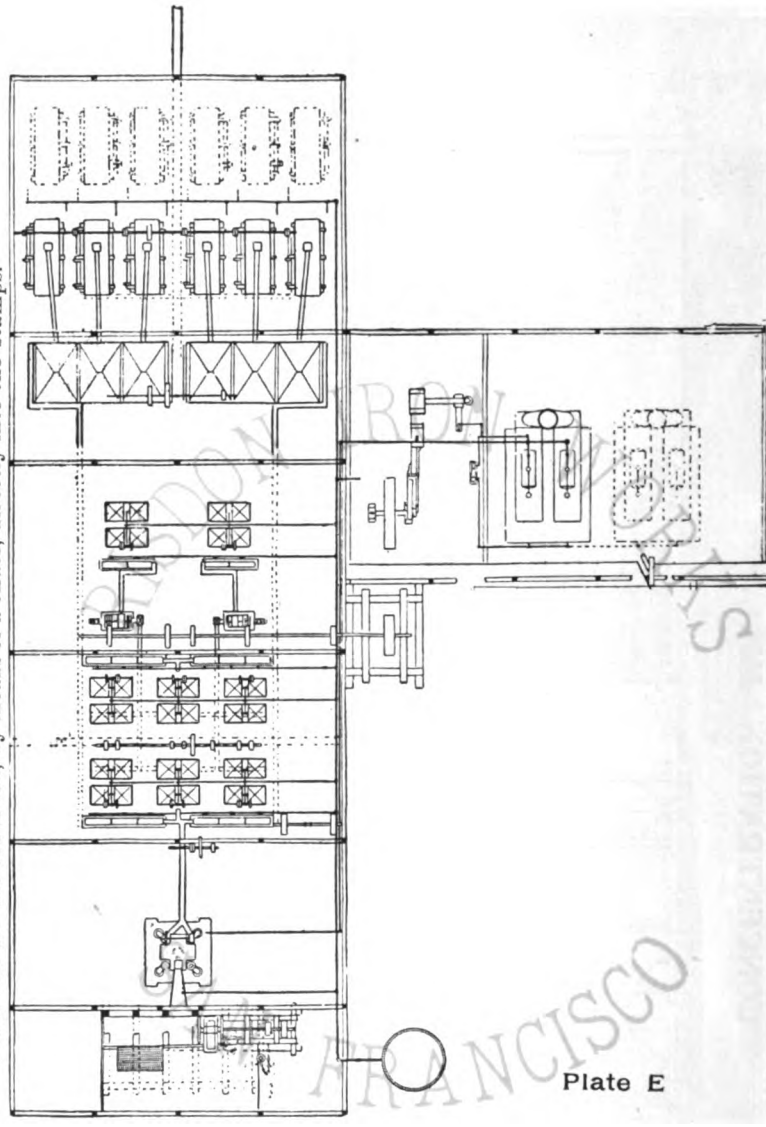


Plate E

The ore after being crushed to the size of the screens, usually ¼ or 3-16 flows directly to four hydraulic separators. By these separators the ore is separated into four different sized classes, three of which are worked upon the jigs shown, the overflow being slimes, flowing to a settling tank. The jigs used are of the Plunger type.

Upon these jigs a separation is made of ore midd.ings and tailings, the middlings flowing from the jigs into the two Grinders, which reduce it to the condition of fine sand and slimes.

The discharge from these mills flows to two compartment hydraulic separators, each of these separators making three products, two of which flow to two-compartment jigs, these jigs making ore and tailings, unless this material should be excessively rich: in such case middlings would be made also and returned by an elevator for further treatment. The slimes from these separators flow into two three-compartment settling tanks, which also receive the slimes from the hydraulic separators spoken of before. In these tanks the mineral portion of the slimes settle in the different compartments and the clear water overflows at the ends. The slimes from these tanks are discharged upon six Johnson Concentrators. The vanners make a clean separation of ore and tailings, the tailings flowing from lateral flumes which discharge into a main flume running through the center of the mill to receive all tailing discharges.

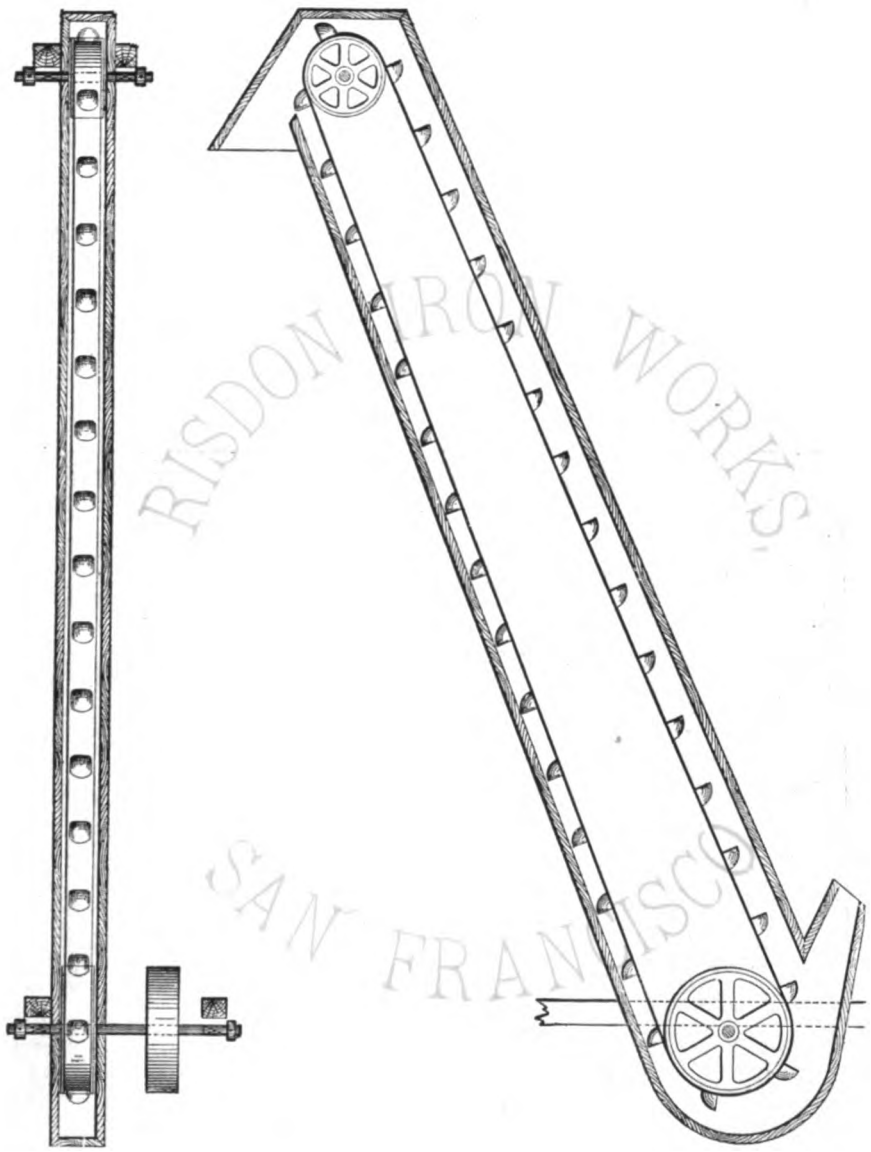
We also show in dotted lines six extra Johnston Concentrators which can be used in case there are sufficient slimes made to warrant their introduction. On ordinary ores, however, six vanners will be sufficient for this plant.

The power plant for this mill consists of a Compound Condensing Corliss Engine, supplied with steam by two 54x16 boilers built to run separately or together.

The general arrangement of this mill can be altered to suit all possible requirements in a mill for treating this kind of ore. We also modify the power plant, depending upon conditions met with at any particular place.

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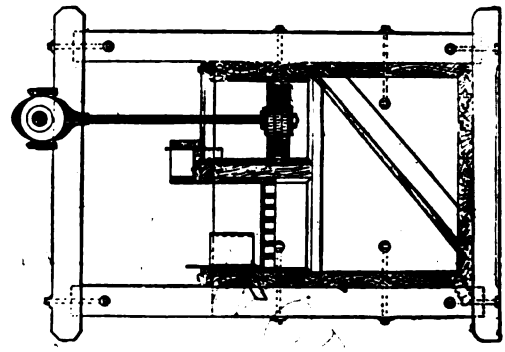
BELT ELEVATORS.

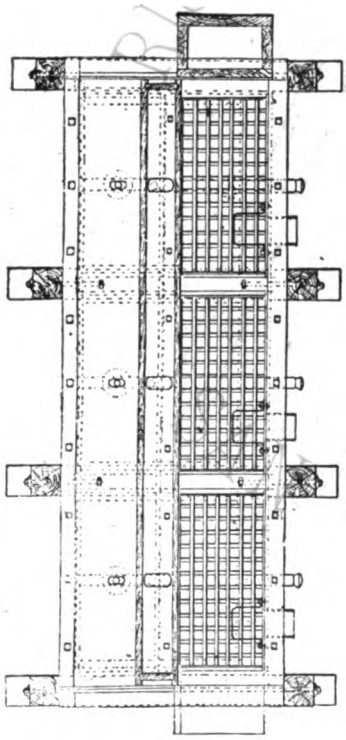


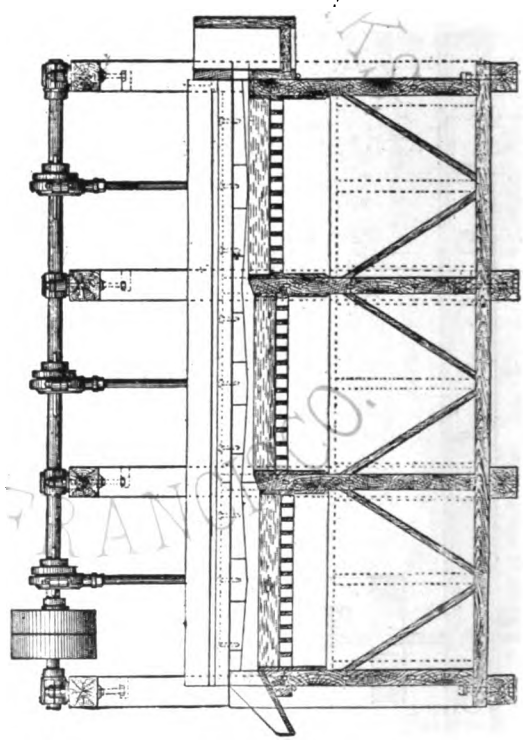
Elevators are used for raising crushed ore from breakers or rollers, according to the arrangement of the mill, to the sizing screens. They are usually of he belt and bucket style, as shown in the plate, and driven by pulley and belt. The Elevator is inclined forward at the top to give a free discharge to the buckets. An Elevator's capacity depends largely on the size and number of buckets, the speed being uniform. Elevators of this kind are encased with wood to prevent loss of spilled material and slopping of water. The lower end, in which the pulley is shown is generally a continuation of the wooden casing, as shown, but when desired we supply iron boots with tighteners. The belt is always of 5 or 6-ply rubber belting of the best grade in the market, and the buckets of heavy sheet iron or steel are fastened to the belt by counter-sunk bolts.

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JIGS





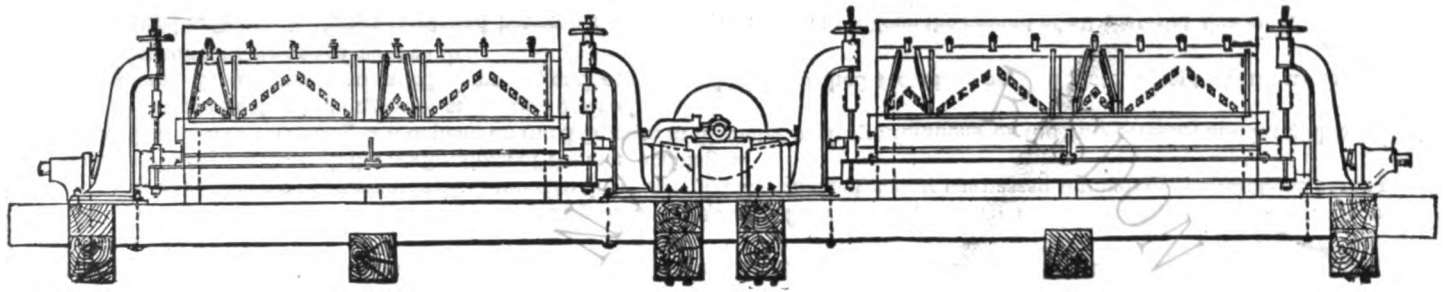


This is the general name for the concentrating machine universally employed for coarse material, and covers a great variety of designs practically all alike in principle and differing little in work done if conditions are equally favorable to each. The principle on which all the well known forms of Jigs work, is the tendency of a mixture of ore particles of approximately similar size, but varying specific gravity, to arrange itself into layers according to gravity when allowed freedom of motion by means of a pulsating column of water. The ordinary type of Jig consists of a water tank divided by a partition above, which does not reach the bottom. On one side of the partition is fixed a horizontal screen on which the sized ore is fed, on the other side a loosely working plunger operated vertically by crank or reciprocating device. The action of this plunger is to cause a regular pulsation of water through the screen; and so effecting the particles of ore resting thereon that the heavier ones settle down through the lighter and either discharge through screen itself or by appropriate gate above screen level, while the lighter particles of rock move on horizontally discharging over side or end of screen frame. The best known Jigs are long wooden tanks with pointed bottoms divided longitudinally by partition (part way down, as described) and laterally into two or more screen spaces discharging one on to the other, and with equal corresponding plunger compartments on the opposite side of longitudinal partition.

Jigs are usually 1, 2, 3 or 4 compartment, the last being generally used when more than two products are required, as for instance a mixture of galena and zinc-blende in rock, or galena with iron or copper pyrites. In the case of 3 or 4 compartment Jigs, the plungers are regulated as to stroke and speed independently of each other and with reference to the work to be done respectively on the screen beds they govern. Several designs are used for the operation of the plungers, the most common being adjustable eccentrics or cranks and lever tappets.

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RITTINGER PERCUSSION TABLE.



This machine is much used in Germany, millmen there being about equally divided between it and the Revolving Buddle. It consists in the single form of a plain inclined table hung from above in such a manner as to move freely at right angles to inclination, and operated by a cam and spring, which produce a quick succession of jars or shocks against a solid frame. The ore in a stream of water is fed on at one of the upper corners and flows down the incline, but the successive shocks affect the particles of rock and mineral, tending to jerk them out in the direction of the shock with a force varying with specific gravity and size. The effect of the double force exerted by the downward current of water and jar at right angles thereto is to make the heavier particles take a diagonal course, and, by a few adjustable buttons on the lower end of table, a separation according to specific gravity is brought about, the heaviest particles moving farther across than the lighter. Along the upper end of the table unoccupied by the pulp discharge, water jets flow on the table in regulated quantity so that its whole surface is washed and the line of the mineral particles controlled.

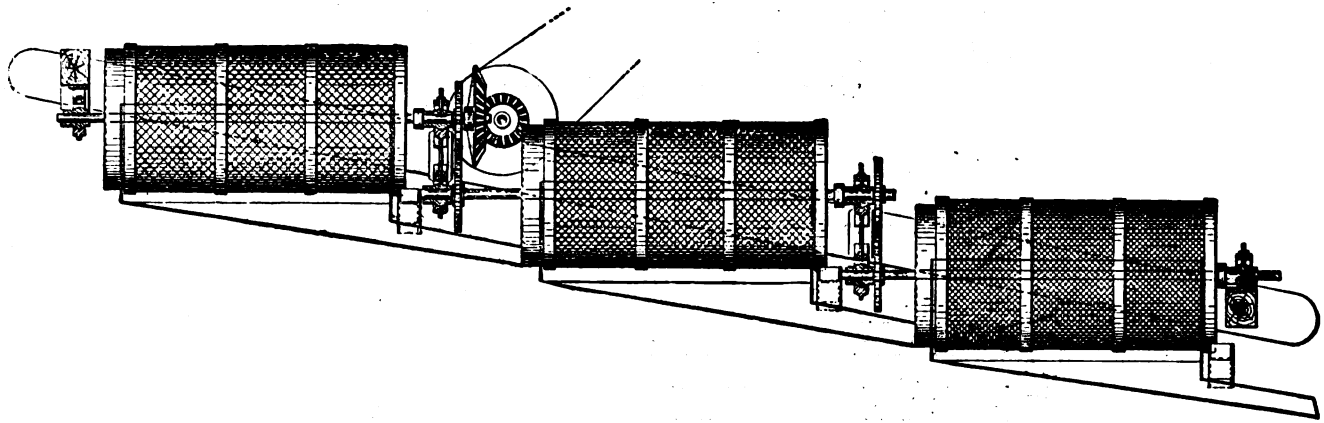
The tables are usually hung in pairs to save space and machinery.

The tables are sometimes of wood, with rubber covering; sometimes of slate, marble or plate-glass, about 4 feet wide by 8 feet long, and varying in number and intensity of shocks with the fineness of ore treated.

A preliminary sizing is necessary to get the best results from these machines, and when properly adjusted they do excellent work. Their capacity is not very large.

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SIZING SCREENS



These are a very important part of a Coarse Concentration Mill as the success of the subsequent treatment depends upon an effective sizing and the proper proportioning of these sizes according to the specific gravity of the various constituents of the ore to be treated. Less than four of these Screens are seldom advisable.

Sometimes compound Screens are employed, in which several sizes are combined. But the more common arrangement is shown in above Plate.

In this Plate the finer material from one screen passes to a second finer screen, and so on to the required number. The material remaining on each screen and afterwards discharged to the proper jig, is thus sized, *i. e.*, it has passed through the perforations of the preceding screen and will not pass through the perforations of the one retaining it.

The closeness of this sizing will depend on the difference in diameter of the perforations of the two screens, and is regulated to suit the character of the ore treated and degree of separation desired.

Revolving Screens are also called trommels, and are covered with punched sheet iron or steel plate, except when very fine screens are required, necessitating the use of wire cloth.

A Revolving Screen is always employed between the two sets of rollers to relieve the second of all material fine enough for the process of sizing.

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SUMMARY OF SPECIFICATIONS OF STAMP MILLS

	No. of Lines.	GOLD MILLS					No. of Lines.	COMBINATION PROCESS GOLD & SILVER STAMP MILLS					No. of Lines.	WET CRUSHING SILVER MILLS TANK SYSTEM					WET CRUSHING MILLS BOSS SYSTEM				
Number of 850 lb. stamps in mill	1	10	20	40	60	100	1	10	20	40	60	100	1	10	20	30	40	60	10	20	30	40	60
Capacity per day in tons	2	30	60	120	180	300	2	30	60	120	180	300	2	35	70	105	140	210	35	70	105	140	210
Number of 4 ft. by 10 ft. Grizzlies	3	1	2	3	4	6	3	1	2	3	4	6	3	1	2	3	4	6	1	2	3	4	6
" of rock breakers	4	1	1	2	2	4	4	1	1	2	2	4	4	1	1	2	2	3	1	1	2	2	3
Size of rock breakers	5	7x9	8x12	8x12	9x15	9x15	5	7x9	7x9	8x12	9x15	9x15	5	8x10	8x10	8x10	9x15	9x15	8x10	8x10	8x10	9x15	9x15
Number of ore bin gates	6	2	4	8	12	20	6	2	4	8	12	20	6	2	4	6	8	12	2	4	6	8	12
Overhead travelers and chain blocks	7	1	1	2	4	6	7	1	1	2	4	4	7	2	2	2	4	6	2	2	2	4	6
Number of ore feeders	8	2	4	8	12	20	8	2	4	8	12	20	8	2	4	6	8	12	2	4	6	8	12
" sq. ft. silvered plates	9	64	128	192	256	384	9	.....	.....	.....	.....	.....	9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
" of 6′ Johnston Concentrator	10A	2	4	8	12	20	10A	4	8	16	24	40	10A	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Number of 4½′ Johnston Concentrator	10B	4	8	16	24	40	10B	8	16	32	48	80	10B	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Number of clean up pans	11	1	1	1	2	2	11	1	1	1	2	2	11	1	1	1	1	2	1	1	1	1	2
" retorts and furnaces	12	1	1	2	2	4	12	1	1	2	2	4	12	1	2	2	3	4	1	2	2	3	4
" special grinding pans	13	.....	.....	.....	.....	.....	13	.....	.....	.....	.....	.....	13	.....	.....	.....	.....	.....	2	4	6	8	12
" chemical mixers	14	.....	.....	.....	.....	.....	14	.....	.....	.....	.....	.....	14	.....	.....	.....	.....	.....	1	2	3	4	6
" 5-ft. amalgamating pans	15	.....	.....	.....	.....	.....	15	5	10	20	30	50	15	5	10	15	20	30	5	9	14	18	27
" 8-ft. settlers	16	.....	.....	.....	.....	.....	16	3	5	10	15	25	16	3	5	8	10	15	2	4	4	8	12
" chemical feeders	17	.....	.....	.....	.....	.....	17	.....	.....	.....	.....	.....	17	.....	.....	.....	.....	.....	2	2	2	4	6
" quicksilver elevators	18	.....	.....	.....	.....	.....	18	1	1	1	1	1	18	1	1	1	1	1	1	1	1	1	1
" amalgam safes and strainers	19	.....	.....	.....	.....	.....	19	4	4	4	5	8	19	4	4	4	5	8	4	4	4	5	8
Size of Corliss Engine, subject to change	20	10x20	12x24	16x42	20x42	24x48	20	14x30	16x36	20x48	24x48	30x48	20	14x30	16x36	18x42	20x48	24x48	14x30	16x36	18x42	20x48	24x48
Number of tubular boilers	21	1	1	2	2	4	21	2	3	4	6	10	21	2	3	4	4	6	2	3	4	4	6
Size of tubular boilers	22	42x14	48x16	54x16	60x16	54x16	22	48x16	48x16	54x16	54x16	54x16	22	48x16	48x16	54x16	54x16	54x16	48x16	48x16	54x16	54x16	54x16
Size of Davidson feed pump	23	1	2	3	3	4	23	2	3	4	4½	7	23	2	3	4	4	4½	2	3	4	4	4½
Size of feedwater heater	24	3	4	5	6	7	24	5	6	8	9	10	24	5	6	7	8	9	5	6	7	8	9
Horse-power required for mill	25	30	46	100	135	200	25	65	130	250	350	600	25	65	130	180	250	350	65	130	150	250	350
Water required per hour (gallons)	26	1600	3200	6400	9600	16000	26	5400	10800	21600	32000	50000	26	2800	5600	8400	11200	16800	2400	4800	7200	9600	14400
Approx. lumber required for mill (M)	27	65	105	135	200	375	27	150	200	275	400	500	27	110	150	190	245	350	90	130	165	200	300
Approx. shipping weight of machinery (tons)	28	30	55	113	163	275	28	100	175	350	500	850	28	87	160	230	300	440	97	173	240	333	475
Prices F. O. B. San Francisco	29	$	$	$	$	$	29	$	$	$	$	$	29	$	$	$	$	$	$	$	$	$	$

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HIGH SPEED CRUSHING ROLLS

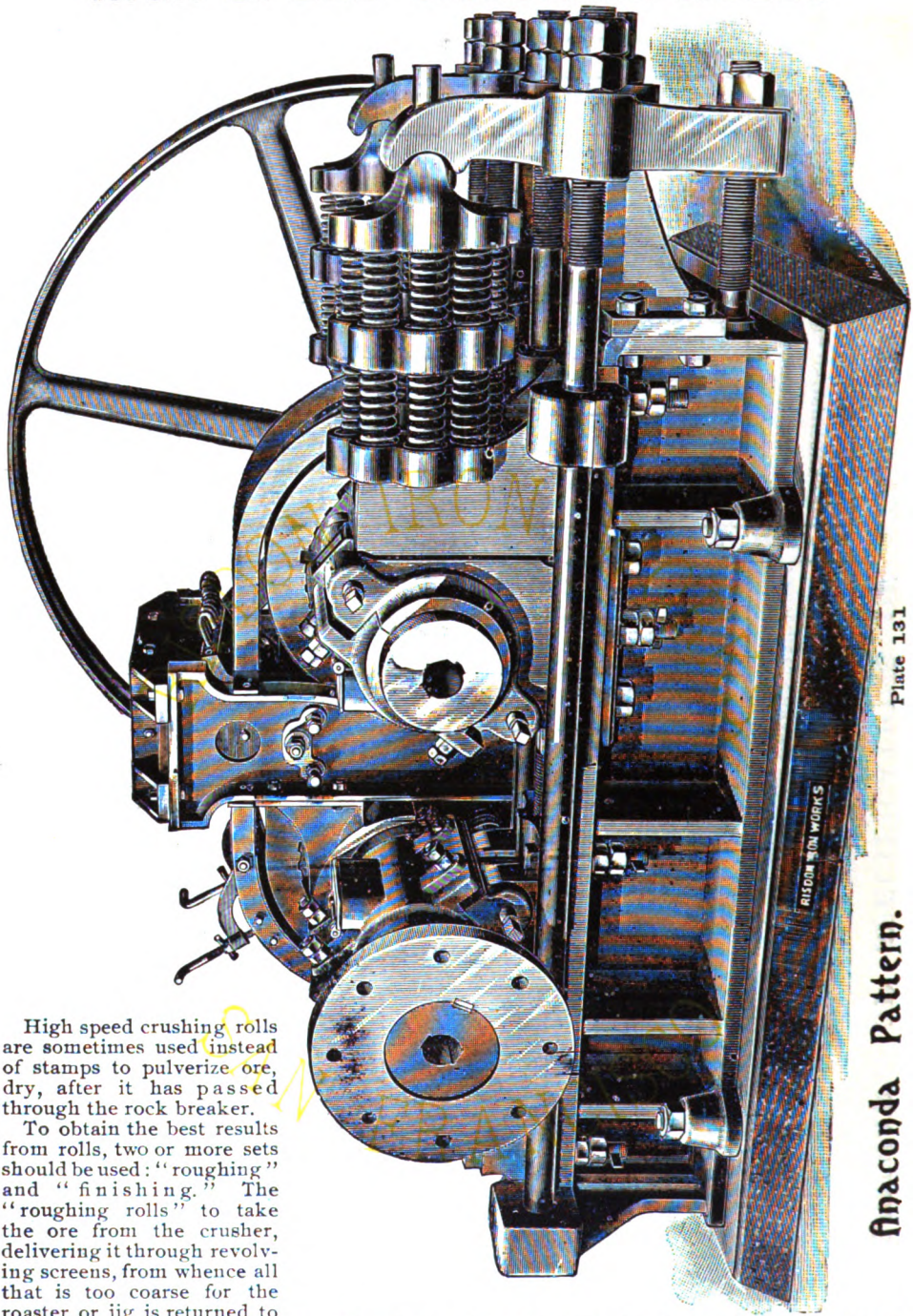


Plate 131

Anaconda Pattern.

High speed crushing rolls are sometimes used instead of stamps to pulverize ore, dry, after it has passed through the rock breaker.

To obtain the best results from rolls, two or more sets should be used: "roughing" and "finishing." The "roughing rolls" to take the ore from the crusher, delivering it through revolving screens, from whence all that is too coarse for the roaster or jig is returned to the "finishing rolls," which are adjusted to reduce the ore to the desired fineness. Any ore still too coarse can again be returned to this or another set of "finishing rolls."

Rolls can be used to the best advantage in large mills when these can be worked continuously to their full capacity. All rolls are steel faced.

		Weight	Price
No. 1.	Laboratory size is 4"x16" Belt	1800 lbs.	.....
No. 2.	Mill " 12"x26¾" Geared	14500 "	.....
No. 3.	" " 15"x26" Belt	16000 "	.....
Capacity of 2 sets per 24 hours		100 tons	
Speed of Rolls		80 revolutions	
Horse-Power		15 to 30	

Special sizes manufactured to order

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PICKING TABLE

This is a large circular Table, covered with punched iron plate and revolving slowly. The rock generally from the rock breaker, falls on to it, spreading out, and is carried by the revolution of the table, till, meeting an inclined scraper, the whole is scraped off into a delivery spout. Around the table boys stand who pick out by sight the large pieces of pure mineral, easily distinguished in the slow moving layer of ore. Waste rock can in like manner be in part separated, so relieving mill of unnecessary work.

This Table is not used on all ores, as in many cases hand picking is not profitable.

CRUSHING ROLLERS

These are made of various designs.

The typical form, the Cornish Roll, consists of two iron rolls varying from 9 in. to 48 in. in diameter, and from 9 in. to 16 in. face, their axles connected by strong gear wheels and revolving slowly against each other. The shaft of one roll is in stationary bearings, the other being in sliding boxes acted on by regulating heavy springs or weighted levers, so that a uniform pressure is maintained between the faces of the revolving rolls to crush the rock introduced between them. The rolls are fitted on the outside with shells of hard iron or steel, and these can be replaced by new ones when worn out. Of late many rolls have been built without the gear wheel connections between their shafts, but run each independently by large belt pulleys, a greater speed of rolls being also employed in this case and the annoying wear of gearing avoided. (See Plate F.) We make these rolls also in various designs, and of any size desired. Our patterns of belt rolls are especially neat, compact and powerful. It is customary to use at least two sets of rolls in concentration mills. The first receives the coarse rock from crusher and the second treats the portion which, after screening, is still above the standard size required. The second, or finishing rolls have to be kept with good even faces to do fine crushing, and, if worn into grooves, can be turned off true again while in place.

The capacity of rolls depends so much on size, speed, nature of ore, and fineness required that no general figure can be given. Two pairs of rolls are sufficient in many concentration mills to crush 50 tons per day. With two breakers and proper screening much more than this can be managed. This can be used either wet or dry.

Rolls of the modern pattern are also being now employed very successfully, in place of dry crushing stamps, on some ores which have to be roasted for amalgamation or leaching. Screens of 16 to 30 holes to lineal inch are generally employed in these cases. Rolls make less dust or slimes than stamps, and are cheaper in first cost and erection: but, as a subsequent treatment of an ore determines its method of crushing, no general comparison of stamps and rolls can be made. A comparison is only possible in the special cases where both methods of crushing are applicable.

LIST OF CORNISH OR CRUSHING ROLLERS.

Dia.	Face.	WEIGHT. Complete	WEIGHT. Shells	List Price.	Dia.	Face.	WEIGHT. Complete.	WEIGHT. Shells.	List Price.
9	9	1,800	300	$ 185	30	12	14,000	1,600	$1,400
12	12	2,500	600	250	30	14	15,000	1,800	1,500
16	10	4,200	600	425	30	16	16,000	2,200	1,600
18	10	4,700	750	475	36	12	15,000	2,200	1,500
20	10	5,800	840	575	36	14	16,500	2,400	1,650
22	10	8,000	1,000	800	36	16	17,500	2,800	1,750
24	12	9,000	1,400	900	40	14	20,000	3,200	2,000
24	14	10,000	1,600	1,000	40	16	22,000	3,500	2,200
26	12	13,000	1,600	1,250	46	14	5,000	5,000	2,500
26	14	15,000	1,800	1,500	46	16	27,500	5,500	2,750
26	15	16,000	1,880	1,600	48	16	35,000	7,000	3,500

Belt Rollers, Plate F, page 104 (no gearing), driven by belt direct, are furnished by us in any of the above sizes. These belt rolls avoid the annoyance of gears wearing out, and are therefore popular. Rolls of this style up to 24 in. x 14 in. can be made sectional for mule back transportation, at an increased cost, the heaviest piece weighing less than 300 lbs.

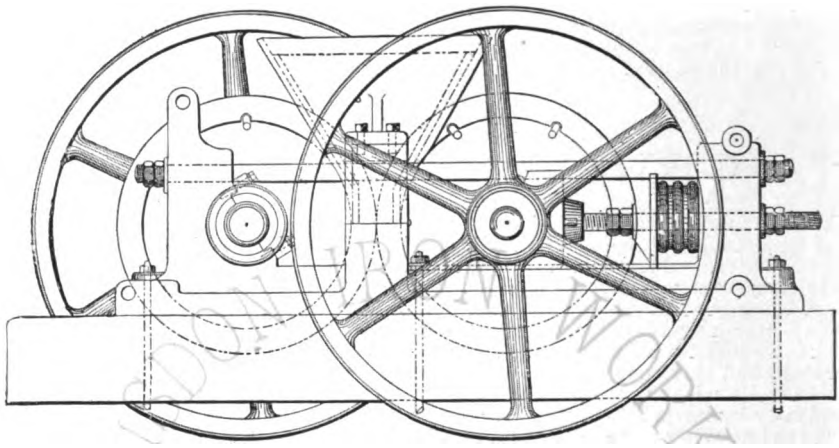
We offer Iron Shells of superior quality, unequalled for uniform wearing surfaces, made by special process lately improved, and guarantee satisfaction.

When desired and preferred, we will furnish Cast or Forged Steel Shells of best quality.

This list price is simply for customers to form idea of cost and on application we will quote net price.

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BELT CORNISH OR CRUSHING ROLLERS



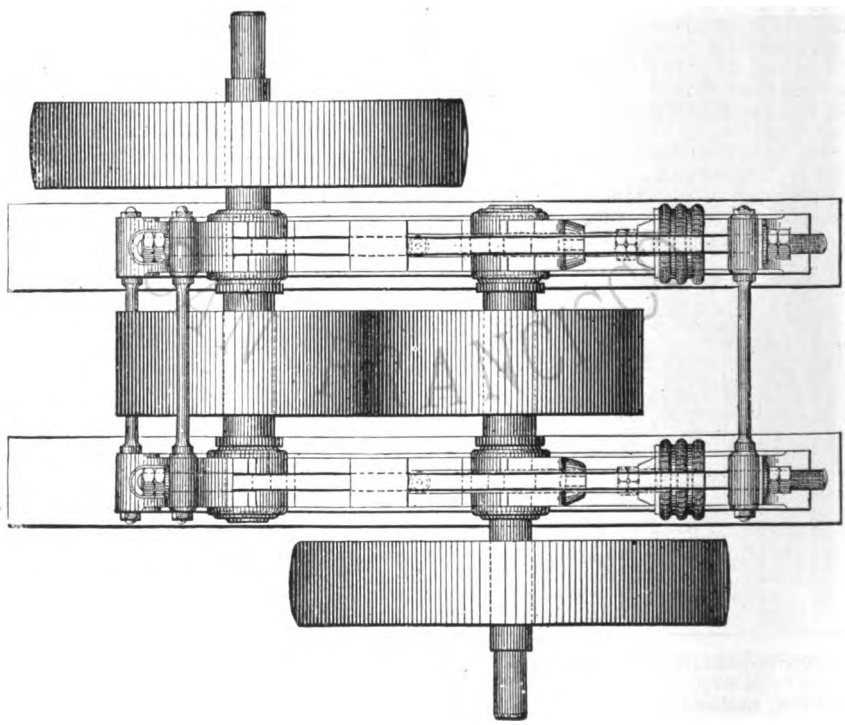


PLATE F.

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Hydraulic Separators.

Plate 1, Fig. 1, represents a Settling Box for the purpose of separating slimes. This box, if carefully proportioned, will give good results and require but little attention.

The slides should be at an angle of not less than 50 degrees from the horizontal as, if made flatter than this, there will be danger of the slimes sticking to the sides instead of settling and discharging through bottom.

The pulp to be settled should be delivered across one end of the box, either by means of holes bored in the bottom of the launder or by means of tongues to distribute the stream evenly, as shown in plate.

It is very necessary that a screen, sufficiently fine, should be used to arrest all chips or foreign matter which would choke the discharge opening.

A partition or dividing board should be used near the inlet end to cut off all surface currents which would prevent a perfect settling of the mineral.

The discharge is made by cutting the end of the box from two to three inches lower than the sides. This should be made perfectly level, so that the water will flow out in a perfectly even sheet. This overflow is caught by the box, as shown, and delivered to discharge launder. At the extreme bottom of the box is located the pulp discharge.

This consists of a 1½-inch or 2-inch nipple, to which is attached a tee; to the branch of this tee is secured a pipe from 2 to 4 feet long, carrying a piece of hose with an adjustable gate upon the end. The other opening of the tee can be closed by means of a wooden plug or iron cock.

By using this method, known as the syphon discharge, a large opening may be used with less danger of obstruction from chips or heavy slimes. Another advantage of this method of discharging is that less fall is required in the mill site.

We have a great many of these boxes in successful operation in different mills.

Fig. 2 represents another method of hydraulic separation.

As will be seen in the illustrations, the pulp flows in through a launder, shown at the left of the separator, and is discharged through another opening shown at the right.

A partition or driving board is used to prevent surface currents flowing direct to discharge.

A pipe is shown, taking clear water from a flume, shown above, to the bottom of this separator, where connection is made by means of a tee, one end of this tee being partially closed by means of a plug with a smaller hole in it. Now, if no clean water were used, it will readily be seen that the discharge from the bottom will consist of a partially concentrated product providing the discharge of the tee was regulated so that part of the material would still discharge through the overflow. This discharge through the bottom would consist of the heavier particles along with part of the slimes or fluid portion. By forcing a stream of water into the bottom, part of this will take the place of the slimes before spoken of, and the discharge will consist of the heavier particles contained in the pulp and a stream of clean water, the slimes, and muddy part being forced to the surface and discharged by the overflow. By regulating the amount of clean water, the pulp discharged may vary from a perfectly clean flow containing the larger and coarser particles of ore to a muddy stream carrying most of the slime.

The bottom cut on page represents the Lake Superior Trough Separator.

This is a modified form of Fig. 1, and consists of three or more compartments arranged in series. The water is fed in and the separation made in the same manner as in Fig. 1.

This separator requires considerable more clean water to make a perfect separation than shown in Fig. 1.

We have a number of designs of these separators, and can modify them to fill any conditions required.

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Hydraulic Separators or Sizers.

Merced Pattern.

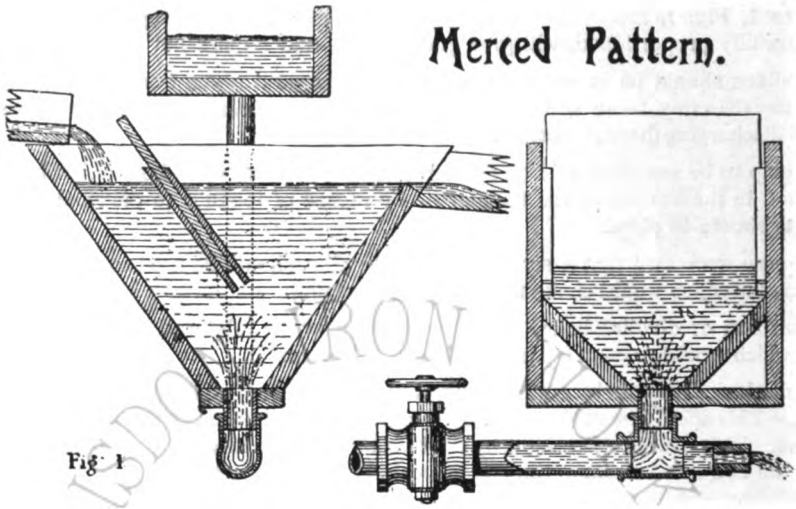
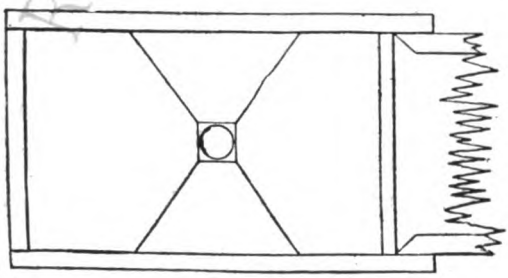


Fig 1



Sulphide Pattern.

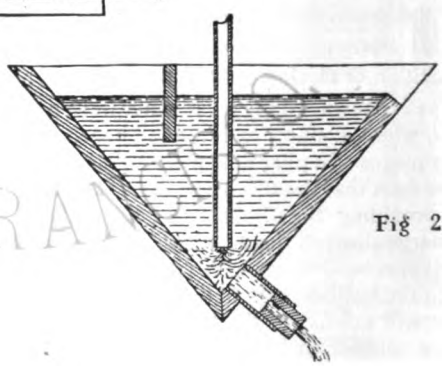


Fig 2

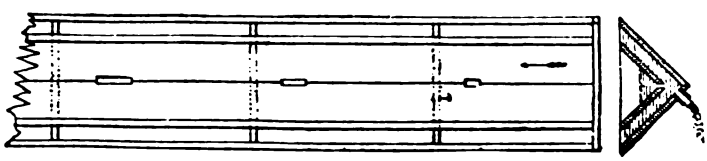


PLATE I.

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LEAD SILVER SMELTING PLANT.

When carbonates of lead or copper or metallic copper ores contain a sufficient percentage of those metals to smelt without the addition of any other flux, their treatment in a water jacket Smelting Furnace is the simplest possible form of smelting, sometimes requiring nothing but fuel and ore. Frequently the percentage of metals is too low to smelt, or, the ores may contain copper pyrites and glance and galena.

In preparing the last-named ores for the furnace, miners are met with the complex side of the smelting process; mixtures of iron ore, limestone or silica are found necessary, and to determine when they are required, and how much of each must be added to the ores is the problem that must be solved to work these ores successfully.

It often happens that ores of a different character are at hand, which flux each other to a great extent, in which case they are mixed together as required and then the necessary flux added.

Plate No. 116 is an isometrical view of a Galena Silver Smelting plant equipped with Baker Blowers, Improved Corliss Engine and Boiler and Sectional Water Jacket Smelters of large capacity.

This may properly be termed a modern smelting plant, and embodies all the latest improvements.

Plate No. 117 is a Galena Silver Smelting Furnace with water jacket rectangular in form, built in sections, and capable of being extended so as to give it a daily capacity of sixty tons of ordinary smelting ore.

These Smelters have been quite generally adopted by the best reduction works in the west, and are found to give excellent satisfaction wherever they are used.

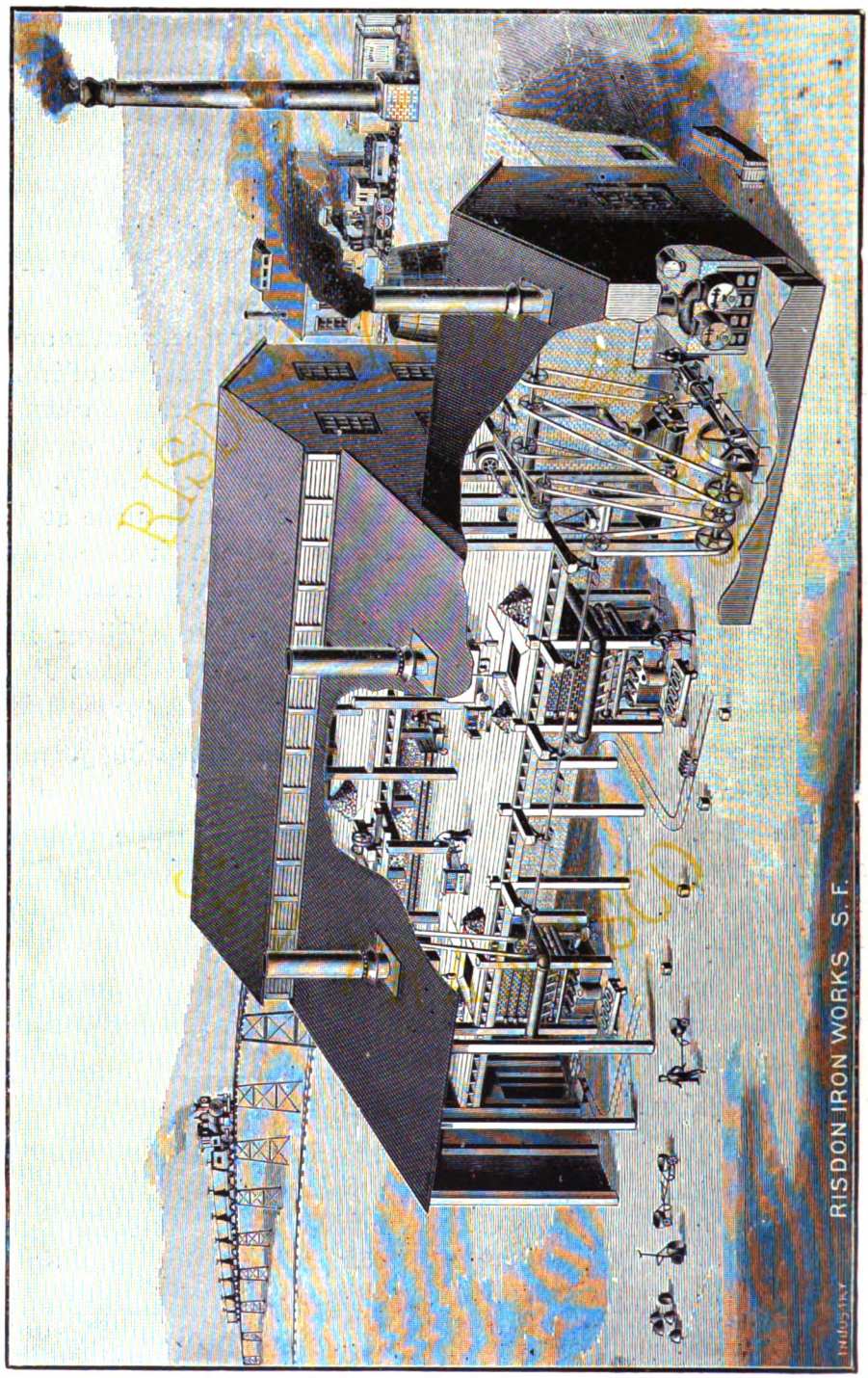
Our regular sizes are

36 inches x 42 inches.
36 inches x 54 inches.
36 inches x 60 inches.
36 inches x 72 inches.
36 inches x 78 inches.

Special sizes built to order.

We furnish plans and specifications with machinery, and quote prices on application.

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LEAD SILVER SMELTING PLANT.

PLATE 116.

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COPPER SMELTING PLANT

Plate 113 is a sectional elevation of an ordinary Smelting Plant for copper ores. The furnace is of the type shown in plate 114. A Baker Blower furnishes the air blast, being placed near the furnace as shown.

The Rock Breaker is located in the rear and above the charging floor, the feed opening being level with the ore receiving floor.

The Engine and Boiler are situated on the furnace floor, and housed in separate rooms to protect their machinery.

Power is transmitted from the engine to a counter shaft and from thence to the Blower and Rock Breaker.

For works of a larger capacity any number of these Furnaces can be used, or a number of the improved rectangular furnaces can be used.

These have a much greater capacity, ranging as high as 60 tons capacity each.

Plans and Specifications are furnished with machinery.

We quote prices on application.

WATER JACKET SMELTING FURNACE

Plate 114 illustrates our Improved Round Water Jacket Smelting Furnace.

The Jacket is made of the best heavy flange iron, formed and riveted as carefully as Steam Boiler work, and fitted with bronze tuyeres.

A removable circular wind box is fitted to the Jacket, and connected to the furnace with any number of tuyeres distributed equally around the furnace insuring a thorough distribution of the blast to all parts of the furnace.

The Tuyeres are thoroughly protected from the excessive heat, and are surrounded by water when they pass through the water jacket.

The Crucible is made on a heavy cast-iron bottom, hinged to the plate, which is supported by cast-iron columns, and is so arranged that it can be instantly dropped, for access to the interior when repairs become necessary.

The Circulation of water is very complete in these furnaces.

The entire structure is complete with Stack, inlet and outlet water pipes, and requires very little brickwork and is quickly and cheaply erected.

These Water Jacket Furnaces are the best form for Simplicity, Strength and Durability, and have the most complete water circulation, as well as great capacity.

The furnace shown is rated as a 30 ton Smelter, and is suitable for Lead-Silver as well as copper ores.

Plans and Specifications furnished with machinery.

Prices quoted on application.

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Plate 113

Sectional Elevation.

Complete Gold and Silver Mills and Smelting Plants, including Power, manufactured in sections for mule-back transportation when required.

RISDON IRON WORKS, SAN FRANCISCO.

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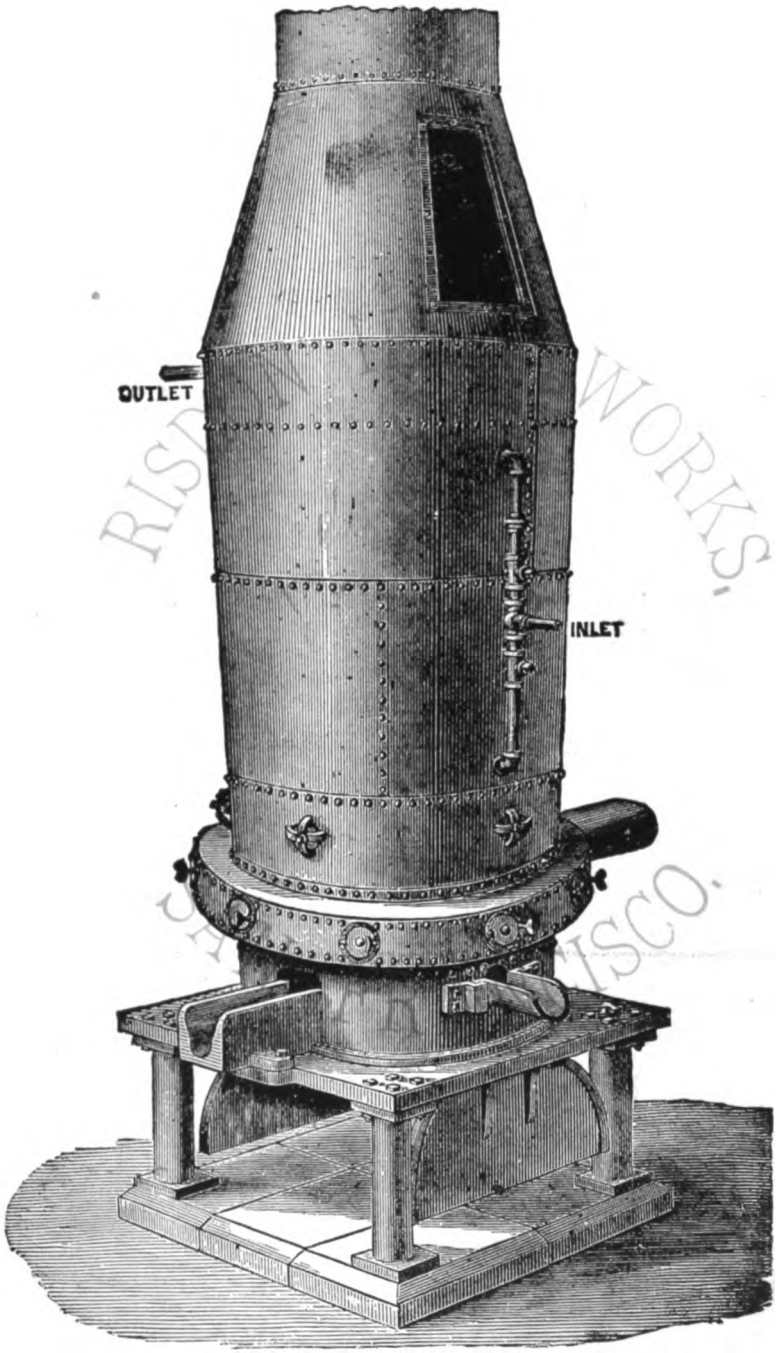


Plate 114

WATER JACKET SMELTING FURNACE.

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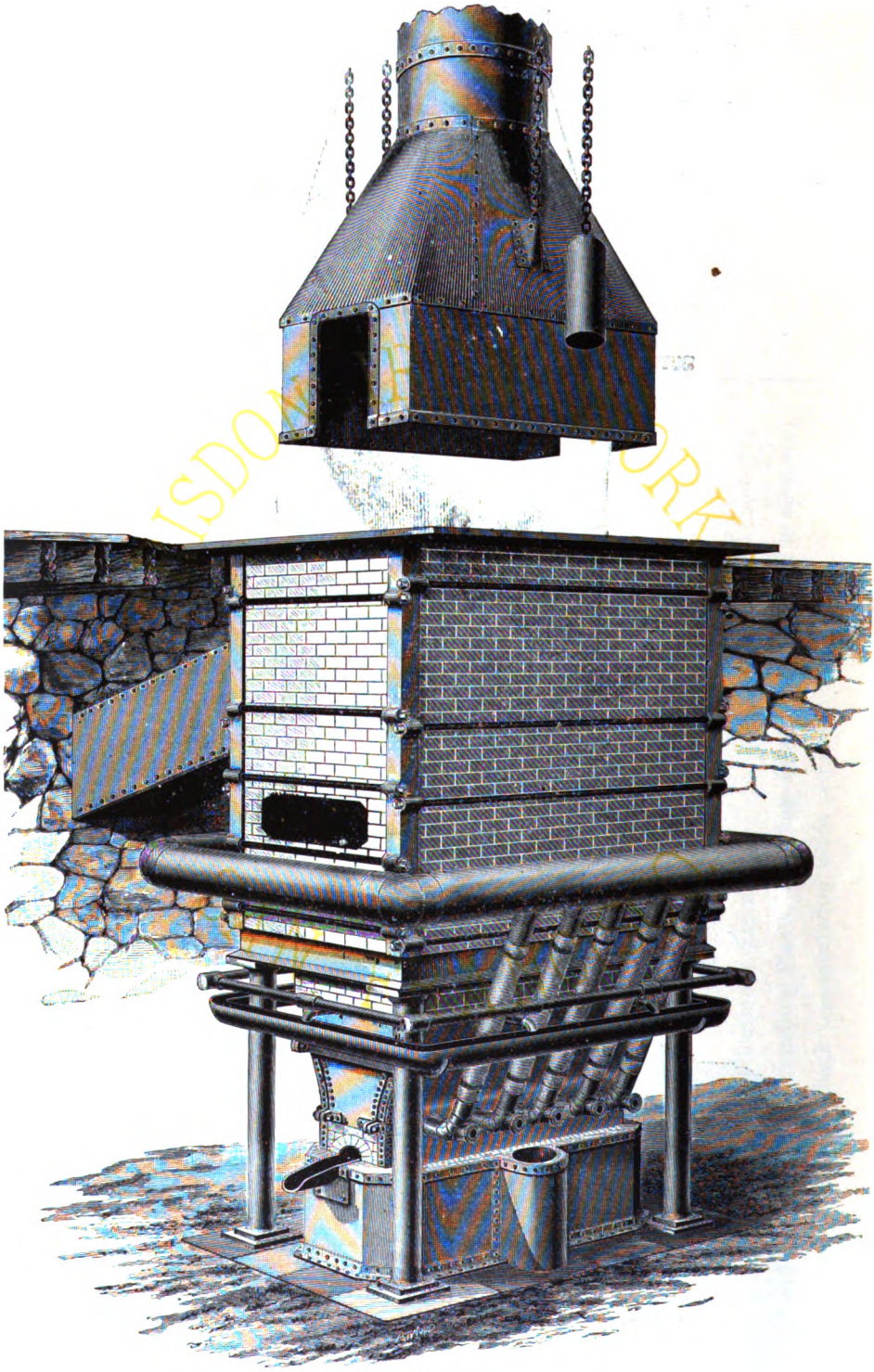


Plate 119.

Wrought Iron Sectional Water Jacket Furnace.

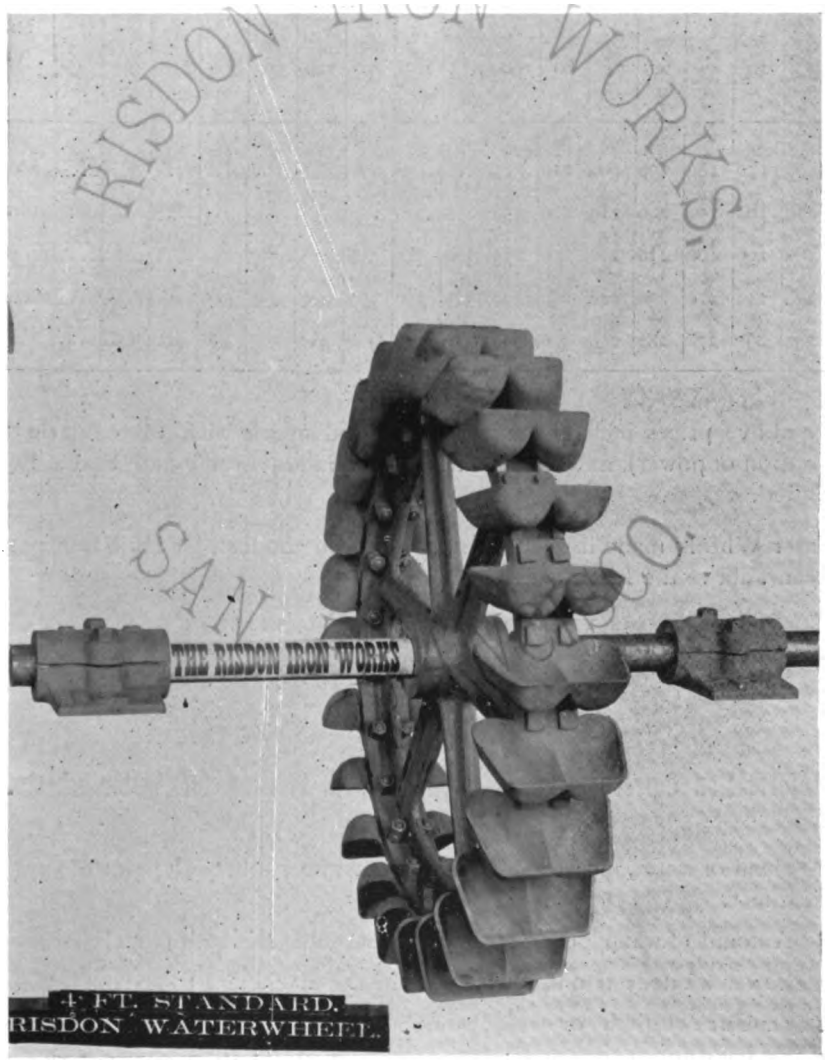
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RISDON

Water Wheels and Motors

FOR HIGH AND LOW HEADS.

HIGHEST EFFICIENCY GUARANTEED.



1000 Risdon Wheels, giving out 10,000 Horse Power.

200 Risdon Wheels Running 5000 Stamps.

RISDON IRON WORKS,

BEALE AND HOWARD STREETS, SAN FRANCISCO, CAL.

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PRICE LIST

OF

RISDON WATER WHEELS.

Diam. Wheels	HORSE POWER.																Shipping Weight
	30	40	50	60	70	80	100	150	200	250	300	350	400	450	500	550	
24''	$160	170	180	190	200	210	225	....	....	....	....	...	....	....	....	....	700 to 1000
36''	170	180	190	200	210	220	250	275	300	....	....	....	....	....	....	....	1100 to 1600
48''	180	190	200	210	220	230	275	300	325	350	375	400	450	....	....	....	1400 to 1800
60''	200	210	220	230	240	250	300	325	350	375	400	450	500	....	....	....	2200 to 2800
72''	250	260	270	280	290	300	325	350	375	400	450	500	550	600	650	....	

The above prices include the wheel, gate and nozzle with three nozzle tips (to give variation of power), and shaft boxes and collars. Frame and Frame Bolts are not included.

Water Wheels made in sections not to exceed 300 lbs., for mule transportation, 15 per cent. above the List Price.

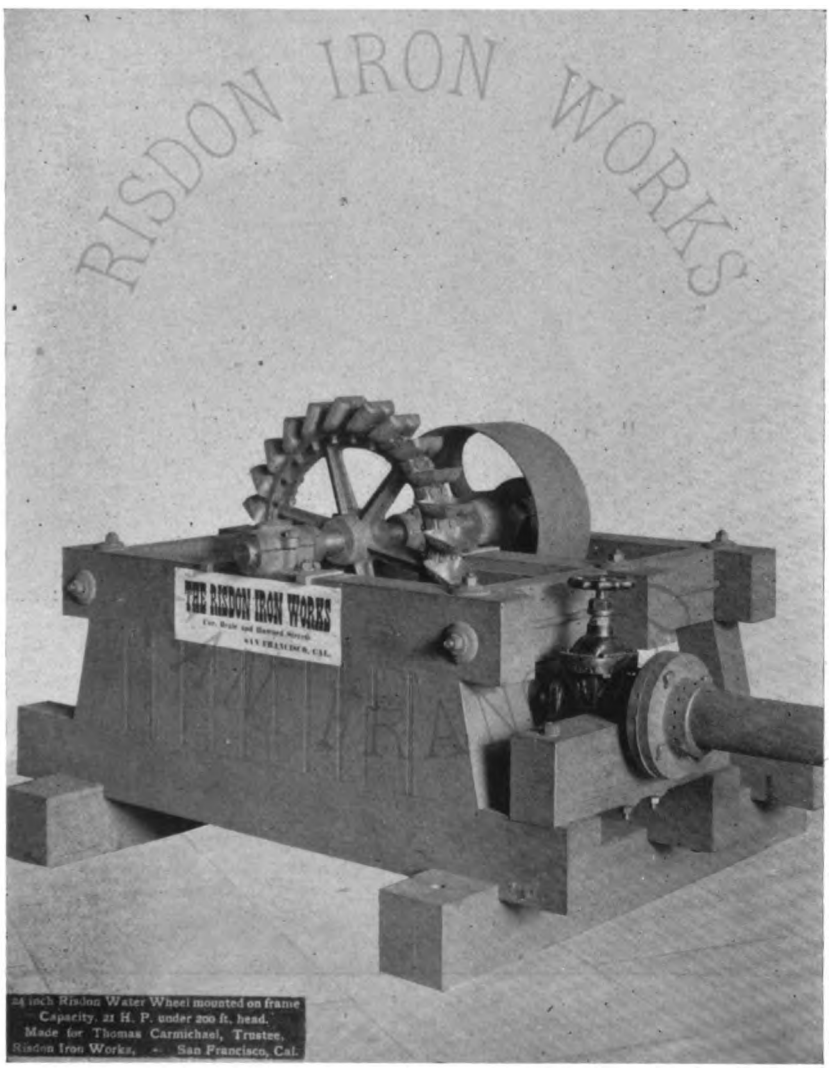
WRITE FOR DISCOUNTS.

Information Correspondents Should Give, in Writing for Water Wheels.

1. Head of water, measured from ditch or water source to point of application, in vertical feet.
2. Amount of water per minute in inches, cubic feet or gallons.
3. Power wanted; if unknown, describe the machinery to be run.
4. Distance of ditch or water source from water wheel, measured along the ground, for length of pipe.
5. If for pumping purposes, how much water is to be pumped and how high.
6. If you have counter shafts, or other shafts to belt, give speed of same.
7. State whether you want Reversible Wheels, Hydraulic Gates, Governors, Safety Valves in connection with your work.
8. State whether water is clear or muddy.

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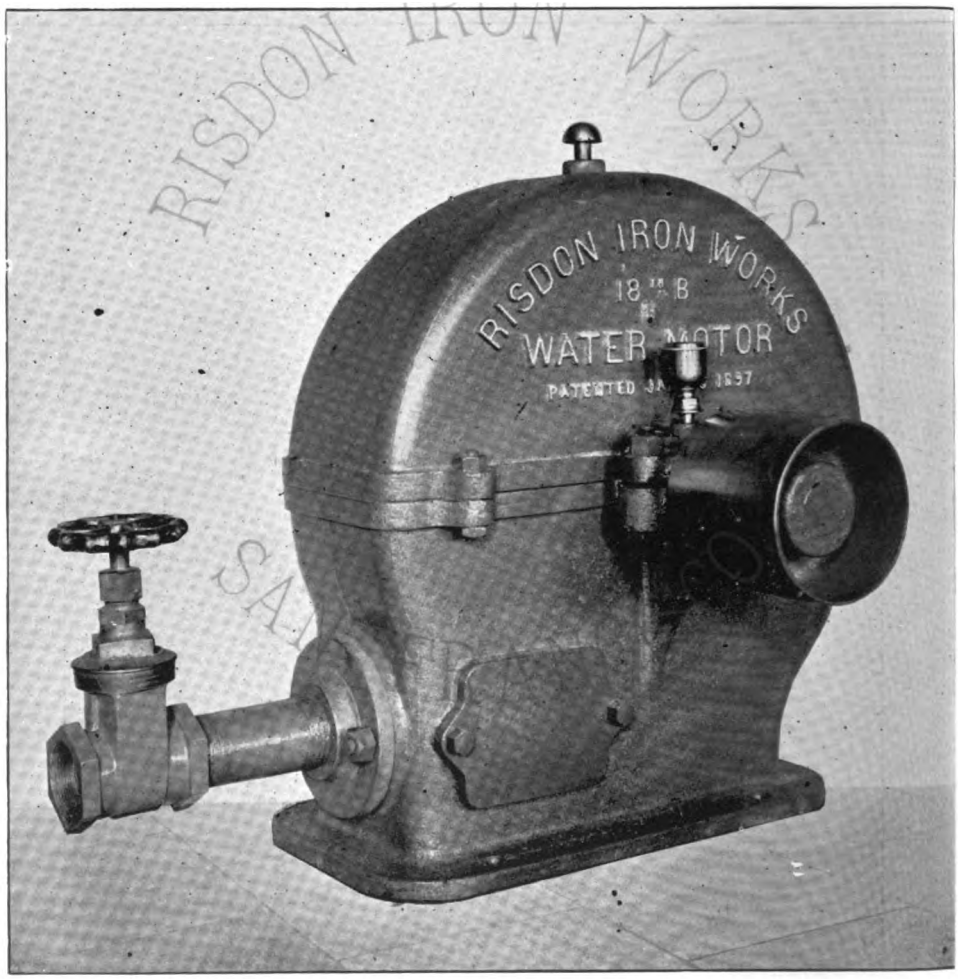
The Risdon Water Wheel.



24 inch Risdon Water Wheel mounted on frame
Capacity, 21 H. P. under 200 ft. head.
Made for Thomas Carmichael, Trustee.
Risdon Iron Works, - San Francisco, Cal.

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The Risdon Water Motor.



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TABLES

FOR CALCULATING THE HORSE-POWER OF WATER

ON

RISDON WATER WHEELS.

MINERS' INCH TABLE

The following table gives the Horse-Power of one miner's inch of water under heads from one up to eleven hundred feet. This inch equals 1½ cubic feet per minute.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0024147	320	.772704
20	.0482294	330	.796851
30	.072441	340	.820998
40	.096588	350	.845145
50	.120735	360	.869292
60	.144882	370	.893439
70	.169029	380	.917586
80	.193176	390	.941733
90	.217323	400	.965880
100	.241470	410	.990027
110	.265617	420	1.014174
120	.289764	430	1.038321
130	.313911	440	1.062468
140	.338058	450	1.086615
150	.362205	460	1.110762
160	.386352	470	1.134909
170	.410499	480	1.159056
180	.434646	490	1.183206
190	.458793	500	1.207350
200	.482940	520	1.255644
210	.507087	540	1.303938
220	.531234	560	1.352232
230	.555381	580	1.400526
240	.579528	600	1.448820
250	.603675	650	1.569555
260	.627822	700	1.690290
270	.651969	750	1.811025
280	.676116	800	1.931760
290	.700263	900	2.173230
300	.724410	1000	2.414700
310	.748557	1100	2.656170

CUBIC FEET TABLE

The following table gives the Horse-Power of one cubic foot of water per minute under heads from one up to eleven hundred feet.

Head in Feet	Horse-Power	Head in Feet	Horse-Power
1	.0016098	320	.515136
20	.032196	330	.531234
30	.048294	340	.547332
40	.064392	350	.563430
50	.080490	360	.579528
60	.096588	370	.595626
70	.112686	380	.611724
80	.128784	390	.627822
90	.144892	400	.643920
100	.160980	410	.660018
110	.177078	420	.676116
120	.193176	430	.692214
130	.209274	440	.708312
140	.225372	450	.724410
150	.241470	460	.740508
160	.257568	470	.756606
170	.273666	480	.772704
180	.289764	490	.788802
190	.305862	500	.804900
200	.321960	520	.837096
210	.338058	540	.869292
220	.354156	560	.901488
230	.370254	580	.933684
240	.386352	600	.965880
250	.402450	650	1.046370
260	.418548	700	1.126860
270	.434646	750	1.207350
280	.450744	800	1.287840
290	.466842	900	1.448820
300	.482940	1000	1.609800
310	.499038	1100	1.770780

When the Exact Head is Found in Above Table

EXAMPLE.—Have 100 foot head and 50 inches of water. How many Horse-Power?

By reference to above table the Horse-Power of 1 inch under 100 feet head is .241470. This amount multiplied by the number of inches, 50, will give 12.07 Horse-Power.

When Exact Head is Not Found in Table

Take the Horse-Power of 1 inch under 1 foot head and multiply by the number of inches, and then by number of feet head. The product will be the required Horse-Power.

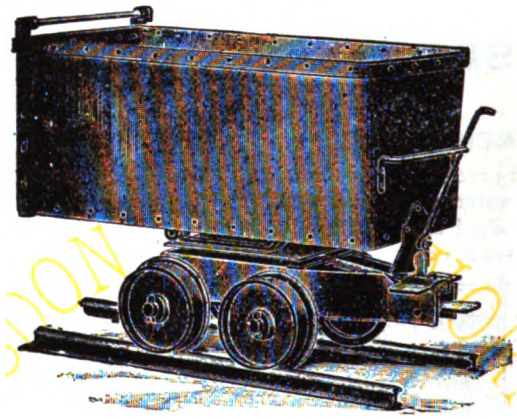
NOTE.—The above formula will answer for the cubic feet table, by substituting the equivalents therein for those of miner's inches.

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RISDON IRON AND LOCOMOTIVE WORKS

SAN FRANCISCO, CAL.

STEEL MINING CARS.



STYLE A

NO.	DIMENSIONS IN INCHES.			THICKNESS.		CAPACITY.	Diam. of Wheels.	Weight.	SIZE AXLE.	PRICE.
	Width.	Depth.	Length.	Sides.	Bottoms.	Cubic Feet.				
1	16	18	30	14	14	5	8	310	1 1/4	$38
2	18	24	36	14	12	9	10	350	1 1/4	40
3	24	21	44	14	12	12	10	380	1 1/4	45
4	24	21	44	12	12	12	10	420	1 1/4	50
5	24	21	44	12	10	12	10	475	1 1/4	60
6	22	24	40	12	10	12	10	600	1 1/2	72
7	24	24	42	12	10	14	10	650	1 1/2	80
8	24	25	48	6	4	16	12	590	1 1/2	75
9	26	24	44	6	4	16	12	700	2	84
10	26	24	48	6	4	17 1/2	12	750	2	90
11	30	25	48	4	4	20	12	685	2	85
12	28	26	48	4	4	20	12	800	2	96
13	30	26	64	4	4	22 1/2	12	850	2	100
14	36	30	72	4	4	45	12	1500	2 1/2	175

Can be dumped end or side; built to run on 18 inch track; 20 cubic feet broken quartz, 1 ton; 18 cubic feet gravel in bank, 1 ton.

We manufacture special sizes and shapes of bodies as well as axles, boxes and wheels, as may be required. All our cars are very substantially made and built of best quality of material.

We also manufacture all kinds of Self-Dumping Skips.

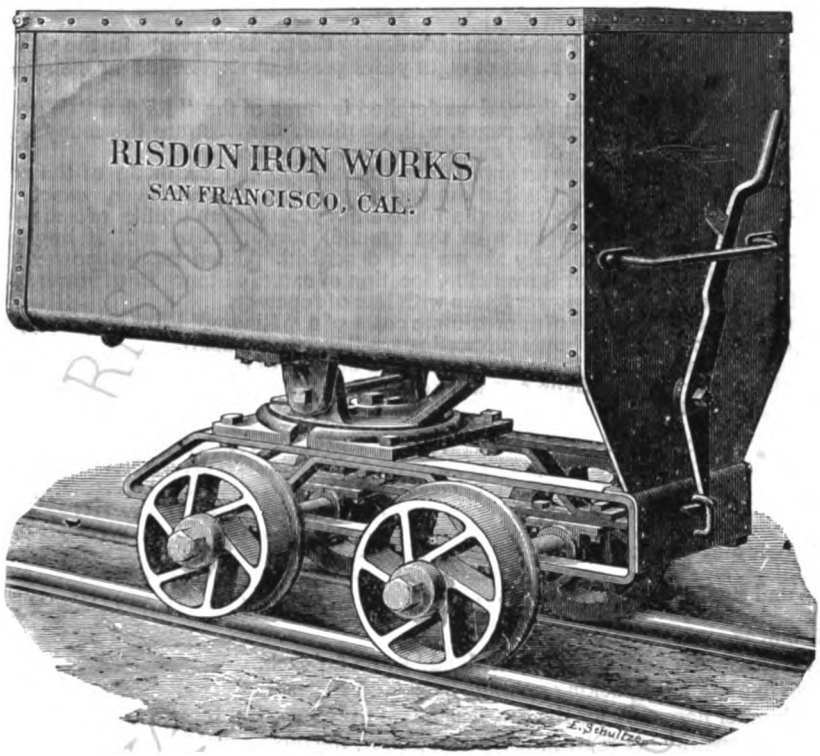
ALL KINDS OF MINING and MILLING MACHINERY.

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.

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MINING CARS

The following cut represents a Side and End-Dumping Mining Car. The door is hinged, and the catch which holds it and that which locks the box in position, are operated by one lever.



Style B

STANDARD SIZES

No.	Dimensions of Box in Inches			Contents in Cubic Feet	Gauge of Track in Inches	Diam. of Wheels in Inches	Weight in Pounds	Price
	Width	Depth	Length					
1	18	24	36	9	18	10	500	$ 70 00
2	20	24	42	12	18	10	575	80 00
3	24	24	42	14	18	10	650	90 00
4	24	24	48	16	18	12	780	100 00
5	24	26	48	17	18	12	800	105 00
6	26	26	48	18	18	12	850	110 00
7	26	28	48	20	18	12	900	115 00

We manufacture special sizes and shapes of bodies, as well as special axles, boxes and wheels, as may be required.

We also manufacture wooden bodies, with or without iron lining.

All our cars have chilled wheels and are very substantially built of steel plates.

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"RISDON" WIRE ROPEWAY.

The Wire Ropeway System for transporting ore, cord wood, sugar cane, lime or other material of similar forms, offers many advantages for performimg such service in a simple and economical manner, and at moderate first cost of plant—which facts have been satisfactorily proven during the 20 years or more that the Wire Ropeway has been in general use.

In mountainous districts, where roads are impracticable, the Wire Ropeway may be regarded as a necessity, as the contour of the ground offers no impediment—the ropeway "leaping from hill to hill," and often, unsupported, crossing chasms thousands of feet in width and many hundred feet in depth.

Valuable improvements have been made during the past few years, in the details of the Ropeway; the same being the result of eight years practical experience in constructing and operating Ropeway Systems.

A careful consideration of the various detailed features of the "Risdon" Wire Ropeway System, described in the following pages, will, we think, demonstrate the many advantages this System possesses over all other methods of transportation.

From the data on page 122 an approximate calculation can be made of the cost of any length of line, delivering any desired amount of material. If, however, exact prices be desired—it will be necessary to have the route surveyed, and a profile of same—(properly filled in with all the characteristics of the ground), forwarded to us. If angles become necessary, they should be carefully shown and described. When motive power has to be applied, state what that power is available, location of same, distance from power to ropeway terminal, also the angle that power forms with line of ropeway.

Below will be found table of approximate costs of a "Risdon" Wire Ropeway, one mile long, to deliver 60 tons in 10 hours supporting trestles 200 feet apart.

Prices stated are to give intending purchasers an idea of the approximate cost.

In order to quote exact figures, it will be necessary to have the ground surveyed and a profile of same sent us.

11000 feet Wire Rope at 18 cents	$ 1980 00
150 Ore Buckets and Hangers at $12 00	1800 00
Machine for lower terminal	450 00
" " upper "	450 00
Guide Sheaves	704 60
Splice Tools and Clamps	20 00
Incidentals	100 00
Cartage and Boxing	50 00
Weight 20,000 pounds.	$ 5,554 00

If Guide Sheaves are brass brushed, add $3 00 for each.

If cut in section for packing on mule back, add 10 per cent.

The lumber necessary for the construction of the above will be 20,000 feet.

When a ropeway is run by independent power, the most suitable place to attach is at the loading terminal. When necessary, it can be attached to any part of the line.

The power necessary to run a ropeway is very little, as will be seen by the following example:

In a ropeway 3500 feet long, delivering 60 tons per day, the altitude of loading terminal being 500 feet above that of the discharging end, each conveyor being loaded with 100 lbs. of material, the decending loaded conveyors furnish the necessary power to operate the line, which is equivalent to 3500 lbs. running at 200 feet per minute on an incline of 8 degrees, or 500 lbs. less friction, suspended vertically from above.

Comparison of Costs of Construction between Wire Ropeway, Tramway, Wagon Road and Pack Trail.

ROPEWAY.

A gravity ropeway one mile long to deliver sixty tons of ore per day, having supporting structures 200 feet apart, can be completed for the approximate sum of $7,500.

The ropeway being in a straight line from mine to mill, there will be no change of direction. In other forms of road, the most suitable grades must be followed, making them from 25 to 50 per cent. longer than a ropeway terminating at the same points.

TRAMWAY.

A tramway 1¼ miles long, 24" gauge using 16-lb. rails and having 4 turn-outs, 2 terminal switches, 7 cars, 5 horses with harness, stable, tools, freight, etc, also making allowance for trestle work, bridges, etc., will cost approximately $11,500. This will not allow for any heavy work, such as blasting, tunneling or expensive bridges.

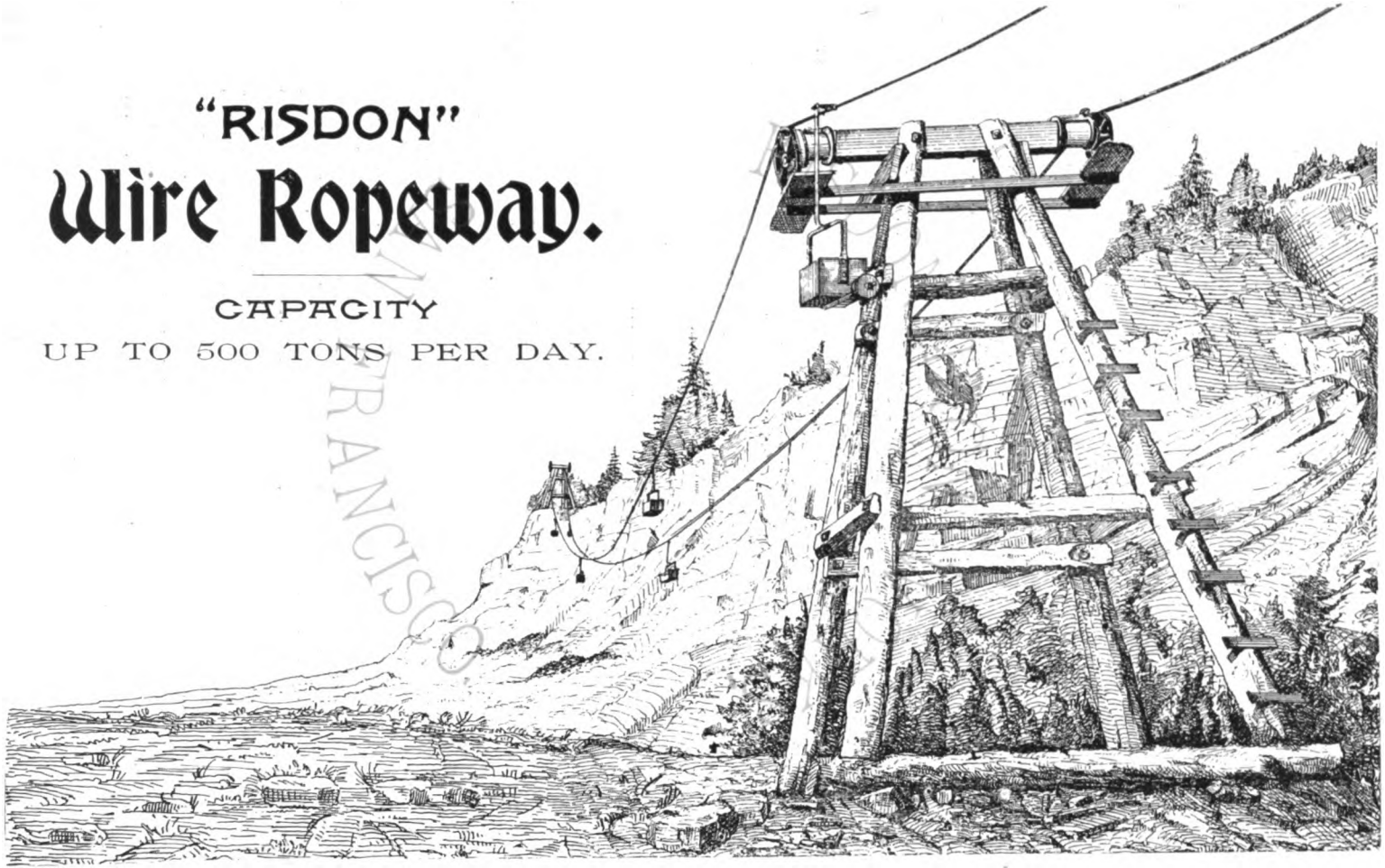
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"RISDON"

Wire Ropeway.

CAPACITY

UP TO 500 TONS PER DAY.



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WAGON ROAD.

A wagon road 1 mile long, constructed over ordinary ground, such as is usually encountered in mining districts, will approximate from $5,000 per mile (with no expensive bridges).

PACK TRAIL.

Two pack trails, 1 mile long, will cost about $3,500. It is necessary to have two trails—one for the incoming and one for the outgoing animals.

COMPARITIVE COSTS PER YEAR OF TRANSPORTATION AND MAINTENANCE BY ROPEWAY TRAMWAY, WAGON ROAD AND PACK TRAIN.

Cost by "Risdon" endless wire ropeway, gravity line one mile long, delivering 60 tons in in 10 hours, the material taken from hopper and loaded by hand.

One man loading, 300 days at $2	$ 600 00
One man at discharging terminal, 300 days	600 00
One man to go over line twice a week	104 00
Lubricating oil	65 00
Changing position of clips on rope three times a year	18 00
Repair to buckets, hangers, etc.	70 00
Cost of operating one year	$1, 457 00

Ore delivered, 18,000 tons at a cost of 8 cents a ton.

MAINTENANCE PER YEAR.

Life of rope 3½ years; per year	$ 428 00
Renewal of clips, sheaves, buckets, etc.	475 00
New Sills under supporting terminal structures after 7 years per year	45 00
Interest on investment	360 00
Total cost of maintenance for one year	$ 1,308 00

Or 7¼ cents per ton; which, added to the cost per ton of operation, would make a total 15¼ cents per ton.

If the amount of ore transported should be 150 tons in 10 hours, or 45,000 tons in 300 days, the cost of transporting same (using the automatic loader), would be $1,575.00, or at the rate of 3½ cents per ton.

COST OF MAINTENANCE FOR ONE YEAR.

Life of rope 3½ years, per year	$ 600 00
Renewal of clips, sheaves, buckets, etc	1,200 00
New sills under supporting terminal structures after 7 years, per year	60 00
Interest on investment	450 00
Making a total for the year of	$2,310 00

Or 5 cents per ton, which added to the cost or operation, would make a total of 8½ cts. per ton.

COST OF TRANSPORTATION BY TRAMWAY DELIVERING SIXTY TONS PER DAY.

Length of line 1 mile, mine being at an altitude of 700 feet above mill, six cars being used each carrying 3,500 lbs. To deliver this amount it would be necessary to receive the ore from a chute.

Three drivers, 300 days, at $6	$ 1,800 00
Stableman, $45 per month, including board	500 00
Feed for 5 horses	912 50
Oil for lubricating	50 00
Repairing cars	160 00
Repairs on road track, bridges, etc	90 00
Replacing rolling stock every two years	455 00
Renewal of ties every 5 years, per year	420 00
Renewing bridges, etc., every seven years, per year	90 00
Renewal of live stock every 5 years, per year	125 00
Shoeing horses	65 00
Interest on investment	690 00
Total cost per year for 18,000 tons delivery	$5,397 50

Or a cost per ton of 30 cents.

This would be under the most favorable circumstances. On a line of this length, having a system of inclined planes, in combination with wagon road or tramway on which the cars are drawn by horses, the cost would be increased on account of the rapid wear of the trail rope and the extra cost of labor employed.

In a gravity inclined tramway, having three separate inclines, with 3 level stretches on which traction is performed by animals, the cost per ton would be as much as 44 cents per ton for 1¼ miles.

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TRANSPORTATION BY WAGONS.

Mine, 1 mile from mill and at an altitude of 750 feet above mill. Delivery, 60 tons per day. Total length of road, about 1¼ miles.

With hired teams loading from chute, 18,000 tons at 55 cents	$ 9,900 00
Yearly cost of repairing road, culverts, bridges, etc	400 00
Loss on road, ¼ of 1 per cent. T. at $20 00	900 00
1 man to handle ore at mill	600 00
Interest on capital invested in road	300 00
Entire cost per year	$12,100 00

Cost per ton, 67 cents (which is a low estimate on transportation in a mountainous country).

TRANSPORTATION BY PACK TRAIN.

Delivering 60 tons per day. Trail, 1¼ miles long.

One year, 18,000 tons, 120,000 cargoes of 300 lbs. each. Packers making their own cargo. The best rate would be 21 cents per cargo	$25,200 00
2 men transferring ore at mill	1 200 00
1 tolling clerk	600 00
Repairs on trail	200 00
Interest on capital invested on road	210 00
⅛ of 1 per cent. of the metal lost on road, from defective sacks and other numerous sources	1,800 00
Total for 18,000 tons	$29,210 00

Or, at a rate of $1 62 per ton.

The above rate of 21 cents per cargo is usual charge throughout Mexico. Where pasturage is scarce and feed high, the rates are raised in proportion.

The cost by this class of transportation in this country is much higher.

It will be seen from the foregoing that the endless wire ropeway is the most economical method of transportation, all things considered.

Difference, in favor of ropeway, over tramway	$ 2,632 50	
Interest	157 95	
Total		$ 2,790 45
Difference, in favor of ropeway, over wagon transportation	9,335 00	
Interest	560 00	
Total		$ 9,895 00
Difference, in favor of ropeway, over pack animals	27,645 00	
Interest	1,658 00	
Total		$29,303 00

The expense attached to the various methods of transportation does not stop here. In the tramway, wagon, and pack train methods of transportation, a deposit has to be accumulated for the winter months, it being impossible to transport when there are heavy rains or when snow falls. This accumulation amounts to about one-fifth of the total for the year, of 3600 tons, which would have to be re-handled at a cost of about 8 cents per ton making $288.00.

With the ropeway, which is not effected by *rain*, or *snow* there can be *continuous daily delivery*.

In case that less than 60 tons per day be required, the cost per ton will be increased in proportion to the wear of the rope, buckets, etc. The help required is the same, whether 20 tons or 60 tons be delivered.

The best and most economical way would be to have the ropeway of from 60 to 100 tons capacity, and run it either two or three days per week, as required.

The amount of material transported can be increased to any reasonable amount, the requirements being heavier rope and larger conveyors, or more of them, as the case may require.

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WIRE ROPE

Wire Rope of the same strength as new Hemp Rope will run on the same sized sheaves; but the greater the diameter of the sheaves the longer it will wear. Short bends should be avoided, and the wear increases in the speed. The adhesion is the same as Hemp Rope.

Wire Rope should not be coiled or uncoiled, but should be wound upon a reel.

As a general rule one Wire Rope will outlast three Hemp Ropes.

To guard against rust stationary ropes should be occasionally oiled with linseed oil or kept well painted or tarred.

Running Rope while in use requires occasional tarring.

TABLE OF TRANSMISSION OF POWER

BY WIRE ROPES

Dia. of Wheel in feet	Number of Revol.	Trade No. of Rope	Diameter of Rope	Horse Power	Dia. of Wheel in feet	Number of Revol.	Trade No. of Rope	Diameter of Rope	Horse Power
4	80	23	3/8	3.3	10	80	19/18	5/8—11/16	55—58
4	100	23	3/8	4.1	10	100	19/18	5/8—11/16	69—73
4	120	23	3/8	5.	10	120	19/18	5/8—11/16	82—87
4	140	23	3/8	5.8	10	140	19/18	5/8—11/16	96—102
5	80	22	7/16	6.9	11	80	19/18	5/8—11/16	64—75
5	100	22	7/16	8.6	11	100	19/18	5/8—11/16	81—94
5	120	22	7/16	10.3	11	120	19/18	5/8—11/16	97—113
5	140	22	7/16	12.1	11	140	19/18	5/8—11/16	113—132
6	80	21	1/2	10.7	12	80	18/17	11/16—3/4	93—99
6	100	21	1/2	13.4	12	100	18/17	11/16—3/4	117—124
6	120	21	1/2	16.1	12	120	18/17	11/16—3/4	140—149
6	140	21	1/2	18.7	12	140	18/17	11/16—3/4	163—173
7	80	20	9/16	16.9	13	80	18/17	11/16—3/4	112—123
7	100	20	9/16	21.1	13	100	18/17	11/16—3/4	140—153
7	120	20	9/16	25.8	13	120	18/17	11/16—3/4	168—184
7	140	20	9/16	29.6	14	80	17/16	3/4—7/8	148—141
8	80	19	5/8	22.	14	100	17/16	3/4—7/8	185—176
8	100	19	5/8	27.5	14	120	17/16	3/4—7/8	222—211
8	120	19	5/8	33.	15	80	17/16	3/4—7/8	217—217
8	140	19	5/8	38.5	15	100	17/16	3/4—7/8	259—259
9	80	20/19	9/16—5/8	40—41	15	120	17/16	3/4—7/8	300—300
9	100	20/19	9/16—5/8	50—52					
9	120	20/19	9/16—5/8	60—62					
9	140	20/19	9/16—5/8	70—73					

The above table gives the power produced by patent Rubber or marlin-lined Wheels and Wire Belt Ropes, at various speeds.

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WORK SHOP RECIPES

Specially useful to Engineers in the Mining Districts

CEMENT FOR CAST IRON

Two ounces of sal-ammoniac, one ounce sulphur, and 16 ounces of borings or filings of cast iron, to be mixed well in a mortar, and kept dry. When required for use, take one part of this powder to twenty parts of clear iron borings or filings, mix thoroughly in a mortar; make the mixture into a stiff paste with a little water, and then it is ready for use. A little fine grindstone sand improves the cement.

RED LEAD CEMENT FOR FACE JOINTS

Equal parts of white and red lead, mixed with Linseed Oil to the proper consistency.

CEMENT—STEAM BOILER

Lithrage in fine powder 2 parts, very fine sand and quick-lime (that has been allowed to slack spontaneously in a damp place), of each 1 part. Mix and keep it from the air.

Used to mend cracks in boilers and to secure steam joints.

It is made into a paste with boiled oil before application.

CEMENT—STEAM PIPE

Good linseed oil varnish is ground with equal weights of white lead, oxide of manganese and pipe-clay.

CEMENT—HYDRAULIC

Made by slacking lime with water containing about 2 per cent of gypsum, and adding a little sand to the product.

The presence of the gypsum tends to delay the slacking of the lime, and also to harden the substance formed after the slacking.

CEMENT—CUTLERS'

Black Resin 4 parts, beeswax 1 part, finely powdered brickdust 1 part. Mix well.

Used to fix tools into their handles.

CEMENT—LEATHER

Gutta percha 1 lb., caoutchouc 4 oz., pitch 2 oz., shellac 1 oz., linseed oil 2 oz. Melted together. Must be melted before being applied.

Used for uniting leather or rubber.

BRAZING

The edges filed or scraped clean and bright, covered with spelter and powdered borax, and exposed in a clear fire to a heat sufficient to melt the solder.

SOLDERS

For Lead, one of tin and one and one-half of lead.

For Tin, one of tin and two of lead.

For Pewter, two of tin and one of lead.

For Brazing (hardest), three of copper and one of zinc.

For Brazing (hard), one of copper and one of zinc.

For Brazing, soft, one of tin, four of copper and three of zinc; or two of tin and one of antimony.

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FLUXES FOR SOLDERING OR WELDING

For Iron or Steel, borax or sal-ammoniac.
For Tinned Iron, resin or chloride of zinc.
For Copper and Brass, sal ammoniac or chloride of zinc.
For Zinc, chloride of zinc.
For Lead, tallow or resin.
For Lead and Tin Pipes, resin and sweet oil.

CASE HARDENING WITH PRUSSIATE OF POTASH

Heat the articles, after polishing, to a bright red, rub the surface over with prussiate of potash, allow it to cool to a dull red, and immerse it in water.

CASE HARDENING MIXTURES

Three parts of prussiate of potash to one part of sal-ammoniac, mixed, or two parts of sal-ammoniac, two parts of bone dust, and one part of prussiate of potash.

MIXTURE FOR WELDING STEEL

One part of sal-ammoniac and ten parts of borax pounded together and fused until clear, when it is poured out, and when cool reduced to powder.

TEMPERING STEEL

Steel in its hardest state being too brittle for most purposes, the requisite strength and elasticity are obtained by tempering—or *letting down the temper*, as it is termed—which is performed by heating the hardened steel to a certain degree and cooling it quickly. The requisite heat is usually ascertained by the color which the surface of the steel assumes from the film of oxide thus formed. The degrees of heat to which these several colors correspond are as follows:

At 430, a very faint yellow. At 450, a pale straw color.

Suitable for hard instruments; as hammer faces, drills, etc.

At 470, a full yellow. At 490, a brown color.

For instruments requiring hard edges without elasticity; as shears, scissors, turning tools, etc.

At 510, brown, with purple spots. At 538, purple.

For tools, for cutting wood and soft metals; such as plane-irons, knives, etc.

At 550, dark blue. At 560, full blue.

For tools requiring strong edges without extreme hardness; as cold-chisels, axes, cutlery, etc.

At 600, grayish blue, verging on black.

For spring-temper, which will bend before breaking; as saws, sword-blades, etc.

If the steel is heated higher than this, the effect of the hardening process is destroyed.

BELT GEARING

The resistance of belts to slipping is independent of their breadth, consequently there is no advantage derived in increasing this dimension beyond that which is necessary to enable the belt to resist the strain it is subject to.

The ratio of friction to pressure for belts over wood drums is for leather belts, when worn .47, when new .5 and when over turned cast-iron pulleys, .24 and .27.

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In high speed belting the tension or the breadth of the belt should be increased in order to prevent belt from slipping. Long belts are more effective than short ones.

A single belt one inch wide, traveling at a velocity of 1000 feet per minute, transmits one horse-power.

A double belt one inch wide, traveling 700 feet per minute, transmits one horse-power.

When a double belt is long and runs over large pulleys it may be calculated to do one horse-power of work at a speed of 500 feet per minute.

The upper side of the pulley should always carry the slack belt.

To throw a belt on to its pulleys, when it has been laid off, it should always be laid on to the pulley that is not in motion first, and then be thrown over the edge of the moving pulley on to its face.

It has been ascertained by trial that a belt will transmit about 30 per cent more power, with a given tension, when the grain (smooth side of the leather) is in contact with the pulley than when the flesh side is turned inward. The leather is also less liable to crack, as the structure on the flesh side is less dense, and the fibres more extensible. The adhesion of belts is greater on polished than on rough pulleys, and is about 50 per cent greater on a leather covered pulley than on a polished iron pulley. Large pulleys and drum may be covered with narrow strips of leather or with longer strips wound spirally. Pulley covers are manufactured in strips of the desired width, and reduced to uniform thickness by machinery. Belts should be kept soft and pliable by applying tallow occasionally and neats foot or liver oil, with a little resin when they become hard and dried.

Rubber belts ought always to be kept free from grease or animal oils. If they slip, moisten the inside of the belt with boiled linseed oil. Some fine chalk, sprinkled on over the oil will help the belt.

RULE FOR FINDING THE LENGTH OF BELTS

Add the diameter of the two pulleys together, multiply by 3½, divide the product by 2, add to the quotient twice the distance between the centre of the shafts, and the product will be the required length.

RULE FOR CALCULATING THE POWER OF BELTING

One inch single belt moving at a velocity of 1000 feet per minute=one horse-power.

One inch double belt moving 700 feet per minute=one horse-power.

Horse-power of any belt equals its velocity in feet per minute, multiplied by its width and divided by 1000, for single, and by 700 for double belts.

RULES FOR CALCULATING THE SPEED OF DRUMS AND PULLEYS

The diameter of the driven being given, to find its number of revolutions:

Rule—Multiply the diameter of the driver by the number of its revolutions, and divide the product by the diameter of the driven, the quotient will be the number of revolutions of the driven.

The diameter and revolutions of driver being given, to find the diameter of the driven that shall make any given number of revolutions in the same time:

Rule—Multiply the diameter of the driver by its number of revolutions and divide the product by the number of revolutions of the driven; the quotient will be the diameter.

To ascertain the size of the driver:

Rule—Multiply the diameter of the driven by the number of revolutions you wish to make, and divide the product by the revolutions of the driver; the quotient will be the diameter of the driver.

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ROUND ROPES

MANILLA, COTTON AND RAWHIDE

—		MANILLA ROPES				COTTON ROPES		RAWHIDE ROPES	
Diameter	Circumference	Weight per Foot	Breaking Strain	Safe Working Load for High Speed Transmission Ropes	Safe Load for Hoisting Ropes	Breaking Strain	Safe Working Load for High Speed Transmission Ropes	Breaking Strain	Safe Working Load for High Speed Transmission Ropes
Inches	Inches	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
.239	¾	.019	560	22	56	700	26	560	56
.318	1	.033	784	32	78	980	40	784	78
.477	1½	.074	1568	62	156	1960	77	1568	156
.636	2	.132	2738	108	273	3416	135	2733	273
.795	2½	.206	4278	170	427	5347	212	4278	427
.955	3	.297	6115	244	611	7393	305	6115	611
1.11	3½	.404	8534	340	853	10667	425	8534	853
1.27	4	.528	11558	460	1155	14447	575	11558	1155
1.43	4½	.668	14784	590	1478	18480	737	14784	1478
1.59	5	.825	18368	734	1836	22960	917	18368	1836
1.75	5½	.998	21952	878	2195	27440	1097	21932	2195
1.91	6	1.18	25536	1020	2553	31920	1275	25536	2553
2.07	6½	1.39	29120	1164	2912	36400	1455	.....	.....
2.23	7	1.62	32704	1308	3270	40880	1635	.....	.....
2.39	7½	1.86	36288	1450	3628	45360	1812	.....	.....
2.55	8	2.11	39372	1594	3987	49840	1992	.....	.....
2.86	9	2.67	47000	1880	4700	58750	2350	.....	.....
3.18	10	3.30	54.00	2168	5420	67500	2710	.....	.....
3.50	11	3.99	61376	2454	6137	.....	.....	.....	.....
3.82	12	4.75	63500	2740	6350	.....	.....	.....	.....
4.14	13	5.58	75700	3028	7570	.....	.....	.....	.....
4.45	14	6.47	82380	3314	8238	.....	.....	.....	.....

NOTE.—The diameter of high speed transmission pulleys for round rope, should not be less than twenty diameters of the rope.

CONCRETE

To make concrete for machinery foundations or retaining walls, use

Six parts of broken rock small enough to go through a 3 in. mesh screen.

Two parts of clean sharp sand.

One part of Portland cement.

Thoroughly mix together when dry. Do not add any water until it is required for use, then add enough water to make a thick mortar; mix in small quantities and use at once; thoroughly tamp with a suitable tamping bar, immediately.

Concrete will set enough in twenty-four hours to carry a load, and in three to four days will be hard enough to run machinery on.

Should broken rock be difficult to obtain, use clean creek gravel of about the same size, instead.

In no case use loam, clay or very fine sand.

For special strength, more cement may be used.

NOTE.—The above is from cable road practice, and may be considered reliable for ordinary uses. For special purposes, special mixtures will be required.

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HORSE POWER OF SHAFTING

REVOLUTIONS PER MINUTE

Diameter of Shaft	1	50	75	100	110	120	130	150
	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
1	0.00.99	.495	.742	.990	1 089	1 118	1.287	1.485
1¼	.0175	.875	1.3125	1.75	1.925	2.10	2.275	2.625
1½	.03	1.50	2.25	3.00	3.30	3.60	3.90	4.50
1¾	.045	2.25	3.375	4.5	4.95	5.4	5.85	6.75
2	.07	3.5	5.15	7.	7.7	8.4	9.1	10.5
2¼	.1	5.	7.5	10.	11.	12.	13.	15.
2½	.130	6.5	9.75	13.	14.3	15.6	16.9	19.5
2¾	.165	7.5	11.25	15.	16 5	18.	19.5	22.5
3	.225	11.25	16.875	22.5	21.75	27.	29.25	33.75
3¼	.275	13.75	21.62	27.5	30.25	32.	34.75	41.25
3½	.33	16.5	24.75	38.	36.3	40.20	42.9	49.5
3¾	.412	20.8	30.9	41.2	45.32	49.44	53.56	61.8
4	.5	25.	37.5	50.	55.	60.	65.	75.
4¼	.6	30.	45.6	60.	66.	72.	78.	90.
4½	.725	35.25	54.27	72.5	79.75	86.	94.25	108.70
4¾	.85	42.5	63.75	85.	93.5	102.	110.	127.
5	1.0	50.	75.	100.	110.	120.	130.	150.
5½	1.325	66.	99.	132.	145.	159.	172.	198.
6	1.725	86.	139.	172.	189.	207.	224.	258.
6½	2.175	108.	163.	217.	239.	261.	282.	326.
7	2.7	135.	202.	270.	297.	324.	351.	405.

Continued—

Diameter of Shaft	175	200	225	250	300	400	500	1000
	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.	H. P.
1	1.732	1.980	2.229	2 475	2.970	3.960	4.990	9.9
1¼	3.062	3.5	3.937	4.375	5.25	7.00	8.75	17.5
1½	5.25	6.00	6.75	7.50	9 00	12.	15.	30.
1¾	7.875	9.00	10.125	11.25	13.5	18.	22.5	45.0
2	12.5	14.0	15.75	17.5	21.	28.	35.	70.
2¼	17.5	20.	22.5	25.	30.	40.	50.	100.
2½	22.75	26.0	29.25	32.5	39.	52.	65.	130.
2¾	26.25	30.	33.75	37.5	45.	60.	75.	150.
3	39.375	45.	50.6	56.2	67 5	90.	112.5	225.
3¼	47.75	55.0	61.875	68.75	82.5	110.	137.5	275.
3½	57.75	66.	74.25	82.5	99.	132.	165.	330.
3¾	71.10	82.4	92.7	103.	123 6	164.3	206.	412.
4	87.5	100.	112.5	125.	150.	200.	250.	500.
4¼	105.	120.	135.	150.	180.	240.	300.	600.
4½	126.87	145	163.	180.	217.	280.	350.	700.
4¾	143.	170.	191.	212.	255.	340.	425.	850.
5	175.	200.	225	250.	300.	400.	500.	1000.
5½	232.	265.	298.	331.	397.	530.	662.	1324.
6	301.	345.	388.	431.	517.	690.	862.	1724.
6½	380.	435.	489.	543.	652.	870.	1087.	2174.
7	472.	540.	607.	675.	810.	1080.	1350.	2700.

This table is calculated for general shafting, transmitting power by belt pulleys. Prime movers carrying gears and main drivers will give 80 to 90 per cent of H. P. given in the above table.

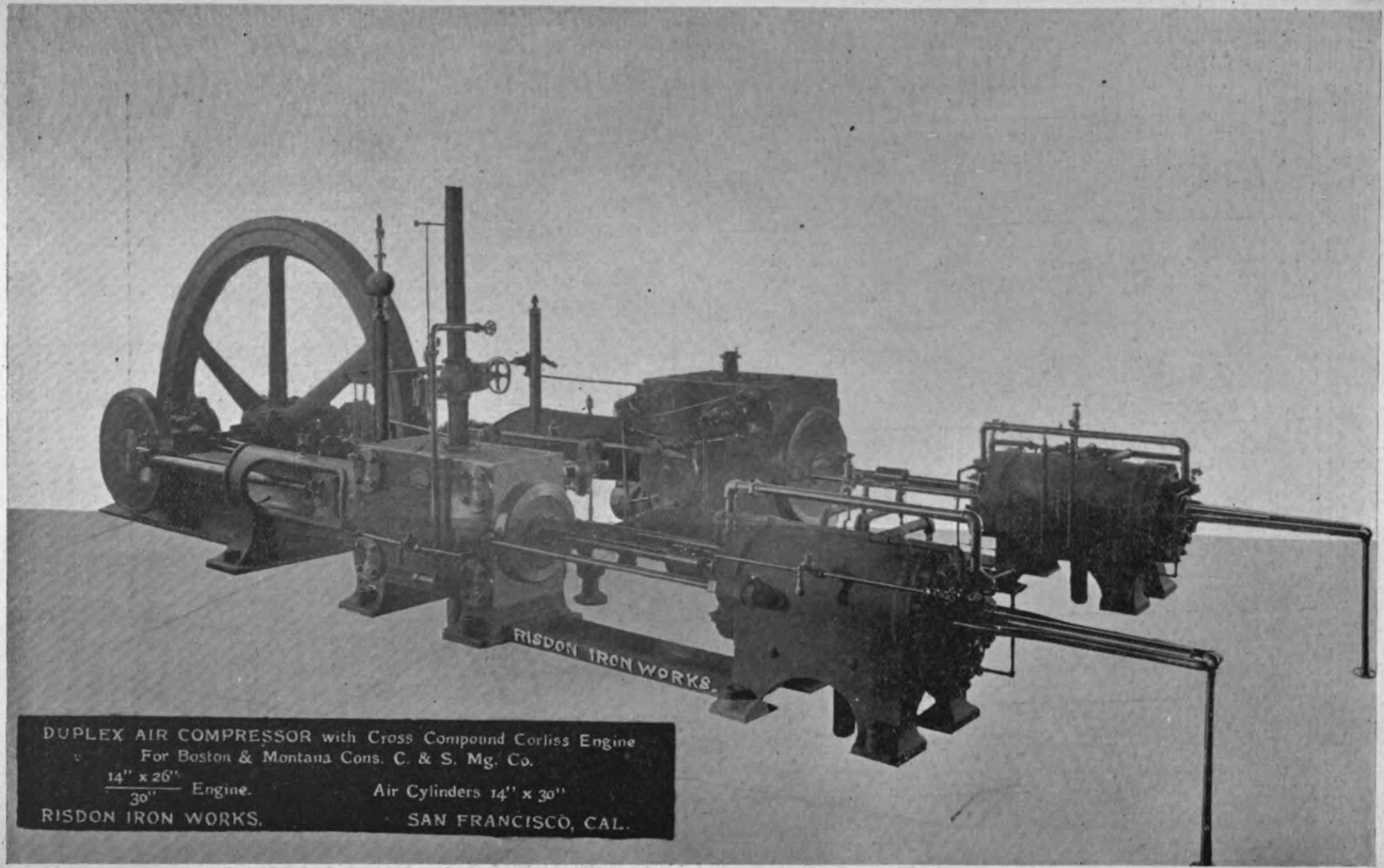
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CIRCUMFERENCES AND AREAS OF CIRCLES

Diameter.	Circumference.	Area.	Diameter.	Circumference.	Area.	Diameter.	Circumference.	Area.
1/8	.393	.0123	18 1/4	57.33	261.58	58 1/2	183.7	2687.8
1/4	.785	.0491	18 1/2	58.11	268.80	59	185.3	2733.9
3/8	1.178	.1104	18 3/4	58.90	276.11	59 1/2	186.9	2780.5
1/2	1.570	.1963	19	59.69	283.52	60	188.4	2827.4
5/8	1.963	.3067	19 1/4	60.47	291.03	60 1/2	190.0	2874.7
3/4	2.356	.4417	19 1/2	61.26	298.64	61	191.6	2922.4
7/8	2.748	.6013	19 3/4	62.04	306.35	61 1/2	193.2	2970.5
1	3.141	.7854	20	62.83	314.16	62	194.7	3019.0
1 1/4	3.534	.9940	20 1/2	64.40	330.06	62 1/2	196.3	3067.9
1 1/2	3.927	1.227	21	65.97	346.36	63	197.9	3117.2
1 3/4	4.319	1.484	21 1/2	67.54	363.05	63 1/2	199.4	3166.9
1 7/8	4.712	1.767	22	69.11	380.13	64	201.0	3216.9
1 5/8	5.105	2.073	22 1/2	70.68	397.60	64 1/2	202.6	3267.4
1 4/4	5.497	2.405	23	72.25	415.47	65	204.2	3318.3
1 7/8	5.890	2.761	23 1/4	73.82	433.73	65 1/2	205.7	3369.5
2	6.283	3.141	24	75.39	452.39	66	207.3	3421.2
2 1/4	6.675	3.546	24 1/2	76.96	471.43	66 1/2	208.9	3473.2
2 1/2	7.068	3.976	25	78.54	490.87	67	210.4	3525.6
2 3/4	7.461	4.430	25 1/2	80.10	510.70	67 1/2	212.0	3578.4
2 1/2	7.851	4.908	26	81.68	530.93	68	213.6	3631.6
2 5/8	8.246	5.411	26 1/2	83.25	551.54	68 1/2	215.1	3685.2
2 3/4	8.639	5.939	27	84.82	572.55	69	216.7	3739.2
2 7/8	9.032	6.491	27 1/2	86.39	593.95	69 1/2	218.3	3793.6
3	9.424	7.068	28	87.96	615.75	70	219.9	3848.4
3 1/4	10.21	8.295	28 1/2	89.53	637.94	70 1/2	221.4	3903.6
3 1/2	10.99	9.621	29	91.10	660.52	71	223.0	3959.2
3 3/4	11.78	11.04	29 1/2	92.67	683.49	71 1/2	224.6	4015.1
4	12.56	12.56	30	94.24	706.86	72	226.1	4071.5
4 1/4	13.35	14.18	30 1/2	95.81	730.61	72 1/2	227.7	4128.2
4 1/2	14.13	15.90	31	97.38	754.76	73	229.3	4185.3
4 3/4	14.92	17.72	31 1/2	98.96	779.31	73 1/2	230.9	4242.5
5	15.70	19.63	32	100.5	804.24	74	232.4	4300.8
5 1/4	16.49	21.64	32 1/2	102.1	829.57	74 1/2	234.0	4359.1
5 1/2	17.27	23.75	33	103.6	855.30	75	235.6	4417 8
5 3/4	18.06	25.96	33 1/2	105.2	881.41	75 1/2	237.1	4476.9
6	18.84	28.27	34	106.8	907.92	76	238.7	4536.4
6 1/4	19.63	30.67	34 1/2	108.3	934.82	76 1/2	240.3	4596.3
6 1/2	20.42	33.18	35	109.9	962.11	77	241.9	4656.6
6 3/4	21.20	35.78	35 1/2	111.5	989.80	77 1/2	243.4	4717.3
7	21.99	38.48	36	113.0	1017.8	78	245.0	4778.3
7 1/4	22.77	41.28	36 1/2	114.6	1046.3	78 1/2	246.6	4839.8
7 1/2	23.56	44.17	37	116.2	1075.2	79	248.1	4901.6
7 3/4	24 37	47.17	37 1/2	117.8	1104.4	79 1/2	249.7	4963.9
8	25.13	50.26	38	119.3	1134.1	80	251.3	5026.5
8 1/4	25.91	53.45	38 1/2	120.9	1164.1	80 1/2	252.8	5089.5
8 1/2	26.70	56.74	39	122.5	1194.5	81	254.4	5153 0
8 3/4	27.48	60.13	39 1/2	124.0	1225.4	81 1/2	256.0	5216.8
9	28.27	63.61	40	125.6	1256.6	82	257.6	5281.0
9 1/4	29.05	67.20	40 1/2	127.2	1288.2	82 1/2	259.1	5345.6
9 1/2	29.84	70.88	41	128.8	1320.2	83	260.7	5410 6
9 3/4	30.63	74.66	41 1/2	130.3	1352.5	83 1/2	262.3	5476.0
10	31.41	78.53	42	131.9	1385.4	84	263.8	5541 7
10 1/4	32.20	82.51	42 1/2	133.5	1118.6	84 1/2	265.4	5607.9
10 1/2	32.98	86.59	43	135.0	1452.2	85	267.0	5674.5
10 3/4	33.77	90.76	43 1/2	136 6	1486,1	85 1/2	268,6	5741 4
11	34.55	95.03	44	138.2	1520.5	86	270.1	5808.8
11 1/4	35.34	99.40	44 1/2	139.8	1555.2	86 1/2	271.7	5876.5
11 1/2	36.12	103.86	45	141 3	1590.4	87	273.3	5944.6
11 3/4	36.91	108.43	45 1/2	142.9	1625.9	87 1/2	274 8	6013.2
12	37.69	113.09	46	144.5	1661.9	88	276.4	6082.1
12 1/4	38.48	117.85	46 1/2	146.0	1698.2	88 1/2	278.0	6151.4
12 1/2	39.27	122.71	47	147 6	1734.9	89	279.6	6221.1
12 3/4	40.05	127.67	47 1/2	149.2	1772.0	89 1/2	281.1	6291.2
13	40.84	132.73	48	150.7	1809.5	90	282.7	6361.7
13 1/4	41.62	137.88	48 1/2	152.3	1847.4	90 1/2	284.3	6432 6
13 1/2	42.41	143.13	49	153.9	1885.7	91	285.8	6503.8
13 3/4	43.19	148.48	49 1/2	155.5	1924.4	91 1/2	287.4	6575.5
14	43.98	153 93	50	157.0	1963.5	92	289.0	6647.6
14 1/4	44.76	159.48	50 1/2	158.6	2002.9	92 1/2	290.5	6720.0
14 1/2	45.55	165.13	51	160.2	2042.8	93	292.1	6792.9
14 3/4	46.33	170.87	51 1/2	161.7	2083.0	93 1/2	293.7	6866.1
15	47.12	176.78	52	163.3	2123.7	94	295.3	6936.7
15 1/4	47.90	182.65	52 1/2	164.9	2164.7	94 1/2	296.8	7013.8
15 1/2	48.69	188.69	53	166.5	2206.1	95	298.4	7088.2
15 3/4	49.48	194.82	53 1/2	168.0	2248 0	95 1/2	300.0	7163.0
16	50.26	201.06	54	169 6	2290.2	96	301.5	7238.2
16 1/4	51.05	207 39	54 1/2	171.2	2332.8	96 1/2	303.1	7313.8
16 1/2	51.83	213.82	55	172.7	2375.8	97	304.7	7389.8
16 3/4	52.62	220.35	55 1/2	174.3	2419.2	97 1/2	306.3	7466.2
17	53.40	226.98	56	175.9	2463.0	98	307.8	7542.9
17 1/4	54.19	233.70	56 1/2	177.5	2507.1	98 1/2	309.4	7620.1
17 1/2	54.97	240.52	57	179.0	2551.7	99	311.4	7697.7
17 3/4	55.76	247.45	57 1/4	180.6	2596.7	99 1/2	312.5	7775.6
18	56.54	254.46	58	182.2	2642.0	100	314.1	7853.9

ADDRESS ALL ORDERS TO RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO, CAL.



DUPLEX AIR COMPRESSOR with Cross Compound Corliss Engine
For Boston & Montana Cons. C. & S. Mg. Co.
$\frac{14'' \times 26''}{30''}$ Engine. Air Cylinders 14'' x 30''
RISDON IRON WORKS. SAN FRANCISCO, CAL.

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"Stickles Mill," Utica Mining Co., Angels Camp, Calaveras Co., California.



60-Stamp Concentrating Gold Mill, "Water Power," 500 lb. Stamps, crushing 280 tons ($4\frac{66}{100}$ tons per stamp) per day, through 40 mesh screen.

ALL MACHINERY BUILT BY RISDON IRON WORKS.

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Catalogue No. 14.

Johnston Concentrator

BUILDERS OF

Improved Bryan Roller Mills, Evans Hydraulic Elevators and Water Wheels, Ore Feeders, Hydraulic Mining Machinery, Rock Breakers, Mining, Pumping and Hoisting Plants.



PUBLISHED BY

THE RISDON IRON WORKS

SAN FRANCISCO

CALIFORNIA.

1897.

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Johnston Concentrator.

Among the many devices and improvements since the discovery of gold in California, none has added so much to the profits of the miner as the concentrator. By it the metallic portion of the ore, rich in gold, which cannot be saved by amalgamation, is saved by concentration at very trifling expense, and in some cases forms the principal source of profit.

The endless traveling belt, with "raised edges and a side-shake or rocking motion from side to side," is entirely of California origin, being the invention of Geo. Johnston, to whom, with E. G. Smith, a patent was issued July, 1867, and by them sold to W. B. Frue in 1874, since which time the machine has been known as the Frue Vanner. This machine has been universally acknowledged to be the standard in performance and results; and no changes have been made in the original Johnston, except a few mechanical details. About four years since Johnston made some radical changes on the side-shake machine, which greatly increased its capacity and enabled it to do much cleaner and closer work. These changes are in part as follows:

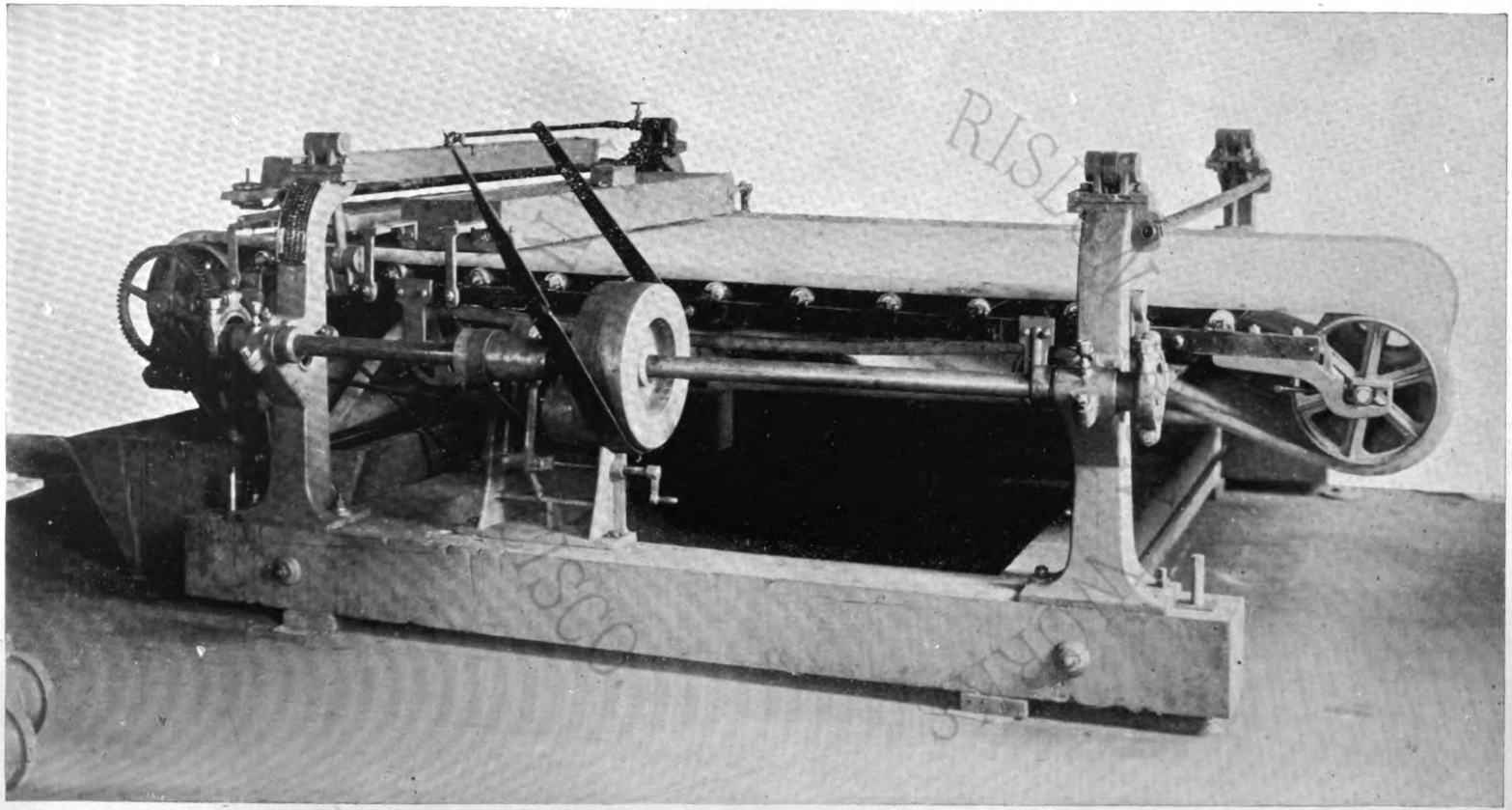
Instead of the horizontal side shake, which piles the sand and sulphurets against the edges of the belt, causing heavy loss, he suspended the shaking frame by four non-parallel suspension links, the upper ends of which, when attached to stationary frame, are about three and one-half inches farther apart than the lower ends when attached to the shaking frame.

General Construction of the Machine.

The stationary frame consists of a solid, bolted, wooden base frame made of heavy timbers, on which are mounted four hollow cast-iron corner posts. These four corner posts are securely fastened and braced to the base frame and to each other, and form the four solid supports for the upper ends of the links by which the shaking table is suspended. On one side of the machine these posts also form the support for the journal boxes of the main driving shaft, and at the head end they support the water box.

The shaking frame is made in the most substantial manner of channel irons and rods, and is so arranged that it can be easily "squared" by lengthening or shortening the diagonal tension rods provided for that purpose. This shaking frame is supported by four suspension links, which are not parallel to each other in the direction of the shaking motion. The upper ends of these links, where they are attached to adjustable shoes on the tops of the four posts above mentioned, are usually about three and one-half inches farther apart than the lower ends where they are attached to the shaking table. This peculiar form of construction for the support of the shaking table is of the greatest importance. The non-parallel position of the links causes the shaking table to receive a slightly undulating motion very similar to that of a batea or miner's pan, and gives a top wash to the sand, while the sulphurets on the belt remain undisturbed. It will be observed that this motion is a radical change from the horizontal side shake, which piles the pulp at the edges of the machine, or the rocker which collects it in the center of the belt.

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Johnston Concentrator, Risdon Iron Works.

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The supply of pulp, after passing through a staggering device, is received upon the metal bottom of the pulp box. This metal bottom is provided with slots which are parallel to the edges of the endless belt, and which are a quarter of an inch wide, twelve inches long, and ten inches apart, and, hence, cause the pulp to fall upon the belt on lines ten inches apart and parallel to the edges of the belt. In falling upon the belt the pulp is distributed over the ten-inch spaces, and separation of sulphurets and sand immediately takes place, the sulphurets passing to the clear water at the head of the table without being again disturbed by the entering pulp, and the sands are washed to the lower end of the table and discharged.

Particular attention is called to this peculiar method of feeding the pulp, because, after the pulp has been once distributed upon the belt, it is not again disturbed by the further supply of pulp; and, after the sulphurets have settled upon the belt, they are carried immediately, and without being disturbed, to the clear water, while the sands have free passage to the lower end of the table.

The sulphurets, while being carried to the head of the shaking table, pass under the clear-water box, which is solidly supported on the main posts. The water from the clear-water box flows first onto a distributor, which is solidly attached to the shaking table, and moves with it; and from the distributor the water is delivered through a series of small tubes, placed about five inches apart, onto the endless belt, in such a manner that the sulphurets are very little disturbed.

The endless belt, carrying the sulphurets, now passes over the roll at the head of the machine and under a roll, whose surface is about one-half inch below the surface of the water in the sulphuret box, where most of the sulphurets will be discharged from the belt. To complete the removal of the sulphurets from the belt, a spray of water is applied thereto from a perforated pipe attached to the posts at the head of the table. There is also a second spray pipe inside the loop of the belt, so that the inside surface of the belt may be washed when desired.

So long as the water in the sulphuret box is being agitated by the traveling belt, a small portion of the finer sulphurets will be held in suspension, and, hence, the overflow water from the sulphuret box should be conveyed to a settling tank where these sulphurets may be free to precipitate, and from which only the clear water may be drawn off. In many cases these settlings are more valuable than the coarser sulphurets.

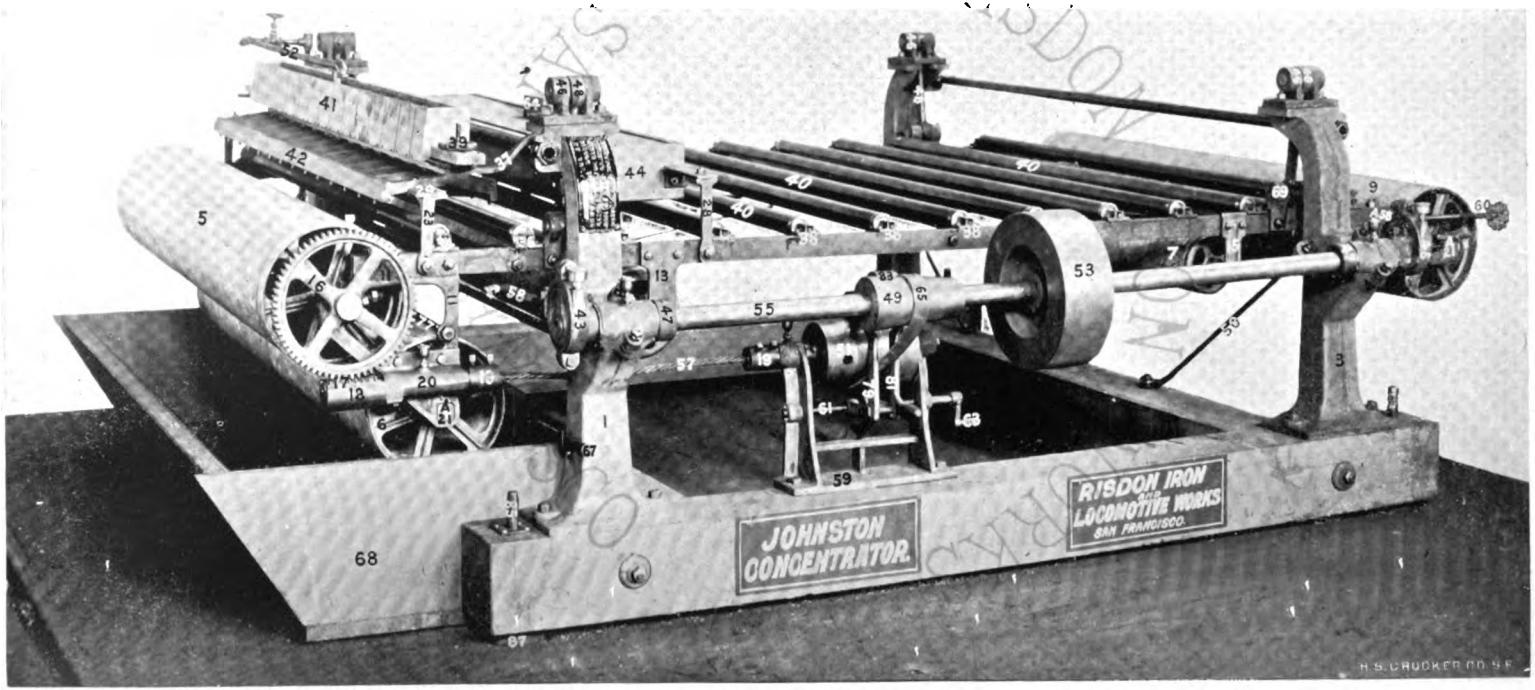
Erecting and Starting the Concentrator.

This concentrator does not require bolting down, nor does it require any special foundation, a solid floor being all that is necessary.

Leveling screws are provided at each corner of the base frame, and this frame should be carefully leveled. After the machine has been put into operation further adjustments may be required, as will be explained in connection with the shaking table.

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No. 2.



Right-Hand Side of Frame Without Belt.

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The corner posts should then be set in place, care being taken to place stretcher qraces in position before bolting posts to foundation frame, after which the skeleton of the shaking table may be laid in on the base frame, where it may be "squared" by the lengthening or shortening of the diagonal tie rods. When the frame is found to be "square," by measuring the same from corner to corner diagonally, the nuts on the tie rods should be tightened firmly into place, and the tie rods should be lashed together where they cross in the center by wire or marline.

The shaking frame is now ready to receive the suspension links, the lugs for which are bolted onto the channel bars. The upper ends of the suspension links are supported by adjustable shoes, which rest on the tops of the corner posts. The small brass rollers may now be placed in position; and, after carefully adjusting the suspension links, the belt may be placed around the shaking frame as follows:

Place under each end of the shaking frame, on its left-hand side, a trestle or other safe support. Disconnect the supporting links on this side and remove the back post. Slip the belt, from the side, over the tail end of the shaking table, and replace the post and suspension link at that end. Remove the front post, slip the belt over the front end of the table, replace the post, and connect up the suspension links as before, being careful to keep the frame as near level as possible, and under no circumstances to let it drop.

The belt can be put on as follows: While only the two posts on the right or driving side are set up, and the shaking frame is square, but still resting on the foundation timbers, the two-inch brass rolls may be put in place, and the belt put over the shaking table. Then the table with the brass rollers and belt can be lifted up and suspended by the links to the main frame.

The distance pipes may now be put in position between the four corner posts and their jam nuts tightened up in place; also put in place the corner braces between posts and base frame.

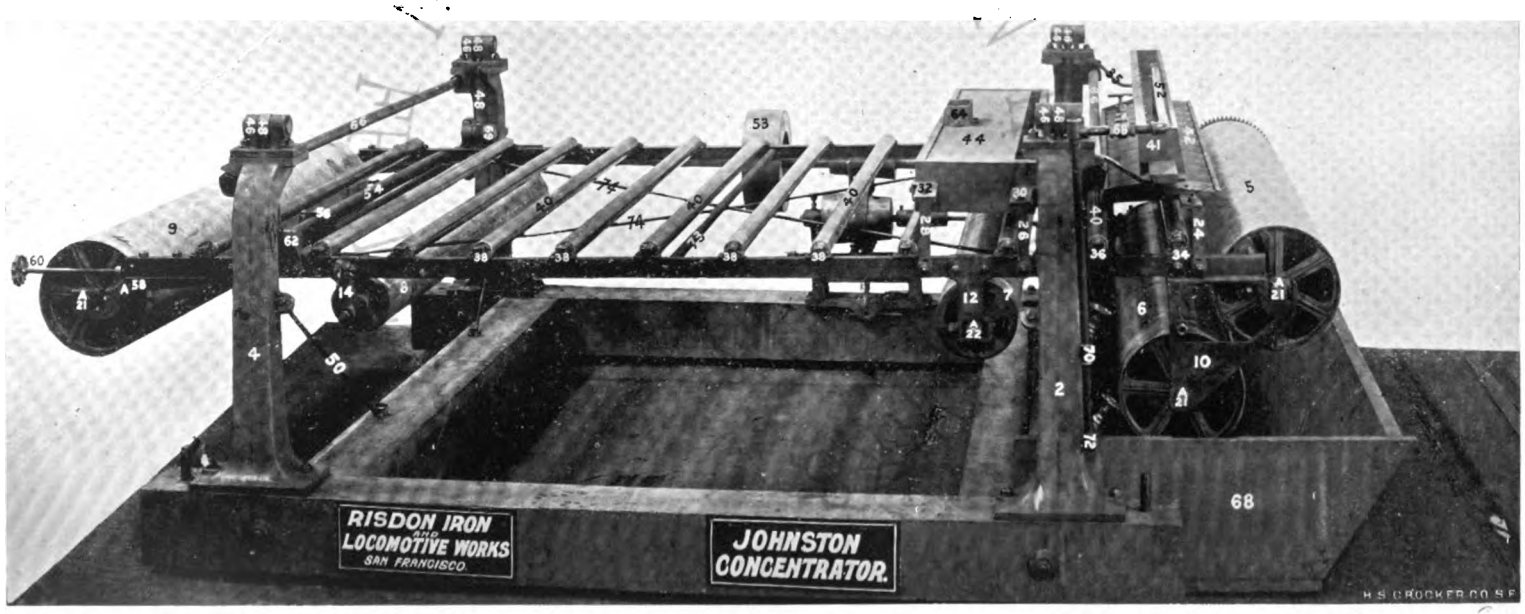
Roller No. 6, with its supports, may now be attached to the shaking frame, being careful to have the roller inside the belt. Roller No. 5 may now be placed in position as shown in cut. End roller No. 9 may also be placed in position, after which rollers No. 7 and No. 8 can be put into position.

When the rollers are all in place tighten the set screws pressing against the boxes of No. 5 roller so as to place the boxes about the middle of the supports. This is done to allow for the adjusting of this roller, which can only be done on the left side of the machine, without taking off the gear wheel.

Sufficient tension should be given the belt by setting out roll No. 9 at the tail end of the machine, being careful that all rollers are parallel to each other.

In placing the pulp box in position, lay two boards lengthwise on the belt, each a few inches wide, one inch thick, and three feet long. Place the pulp box on these strips, being careful that they are so located as to come between the discharge openings in the bottom of the pulp box. Raise the supports for the pulp box that are attached to the shaking table until they are snug under the lugs at the ends of the pulp box, remove the strips of board above referred to, and bolt the pulp box firmly in place.

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Left-Hand Side of Frame Without Belt.

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The water box and its distributor may now be readily put in place, and the erection of the machine easily completed.

After the machine is ready to run, the end rolls may be squared by measuring their distance from the end of the shaking frame. If it is found, on starting the machine, that the belt runs to one corner, it shows that the belt should be tightened at that corner, as it always runs to the short or slack corner. For the purpose of correcting it, set out that corner by three or four quarter turns of the set screw. This may be found sufficient, unless it has got a great deal out of place, when it will require further adjustment. As soon as it stops traveling in the wrong direction it will not be necessary to set it out any further, as the change which stopped its running astray will soon bring it back; then it will be necessary to see that it does not go too far that way.

No lost motion should be allowed in any of the rollers, as it increases wear and prevents good work being done. The jar caused by this lost motion will cause the sands to pile up on one side or other of the belt, even when the shaking frame is perfectly level. If there is a filling up of sand on one side, and no jar to cause it, then the side of the machine on which the sand is accumulating is the high side of the table, and that side must be lowered or the other side raised. If the sand corner commences at the bottom of the table it shows that the lower end of the table is the end that requires attention; but, if the upper end of the table is where the sand corner commences, then that is the corner which is out of level. When leveled, with a piece of board or a broom, press the excess of sand to the center of the belt, and allow the pulp of a proper consistency to pass down on that side. If the proper level has been attained it will soon work of the excess of sands and maintain an equal distribution. No sand corner should be allowed on the belt. It is not only unnecessary, but is conducive of bad work and loss in sulphurets.

Grade or Slope of the Belt.

The proper grade for the belt is from one-fourth to five-sixteenths of an inch to the foot. This is about the range, and depends on the character of the material being worked.

Consistency of the Pulp.

At all times the pulp must be thin, so as to allow the sulphurets to settle on the belt. In addition to judging the pulp by feeling, you can further test its condition by panning, for which purpose an enameled sheet-iron batea is recommended, as very accurate work can be done with it. The danger of getting a prospect from a previous sample owing to the rough bottom of a pan or wooden batea is avoided, as the enameled batea can be thoroughly washed after each test.

Sulphuret Box and Foundation Frame.

The sulphuret box and foundation frame can be made at the mill if it is desirable to save freight. A blue-print will be sent showing their construction and their cost at the works. $8.00 for six-foot machine and $6.00 for four-foot-six-inch machine will be deducted from the prices quoted if they are not wanted.

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Amount of Water Required.

For a five-stamp mill one-half to one miners' inch of water is required. This is equal to five and four-tenths to ten and eight-tenths gallons per minute. If water is scarce, that leaving the concentrator can be settled and more than half of it returned for use. Close and clean concentration cannot be done without sufficient water.

Weights of the Machines.

A six-foot, moulded edge, rubber-belt machine complete, as shown in cut, weighs, when boxed, 3,085 pounds. Of this the foundation frame weighs 480 pounds, and the sulphuret box 125 pounds.

A four-foot-six-inch, moulded-edge, rubber-belt concentrator when boxed ready for shipment weighs about 2,650 pounds. Of this the foundation frame weighs 400 pounds and the sulphuret box 100 pounds.

Capacity.

A six-foot belt is sufficient to handle the pulp from five stamps crushing twelve tons per day of 24 hours.

A four-foot six-inch machine will handle eight tons per 24 hours.

Directions for Oiling.

The box under the screw gear should have just enough oil in it to touch the bottom of the screw, and not enough to slop over. The bearings should be regularly oiled and kept clean. No lost motion should be allowed with any of the rollers.

Floor Space Required.

Six-foot belt machine covers a floor space of eight feet nine inches by eleven feet, and for convenient working requires a space of eleven to twelve feet by sixteen feet. Four-foot-six-inch belt machine covers a floor space of seven feet three inches by eleven feet, and for convenient working requires a floor space of nine feet six inches to ten feet by sixteen inches.

Setting the Counter Shaft.

The counter shaft to drive the Johnston Concentrators is usually placed in a line parallel with the main shaft of the mill. By this arrangement the counter shaft is placed at right angles to the crank shaft of the concentrator, and renders a quarter-twist belt necessary.

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The illustration herewith shows the position of the pulleys and shafts.

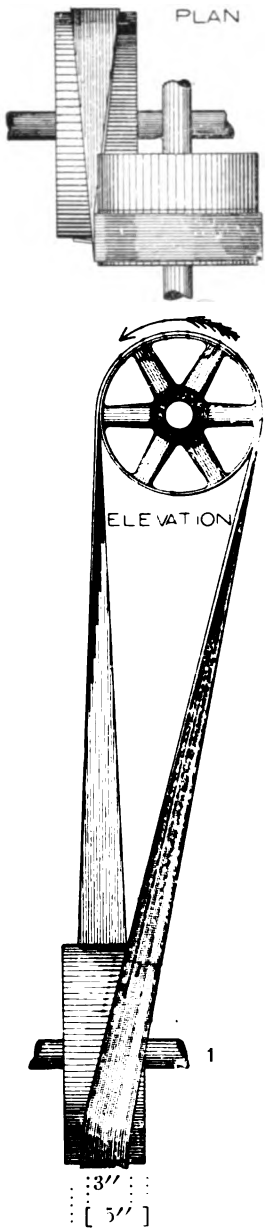
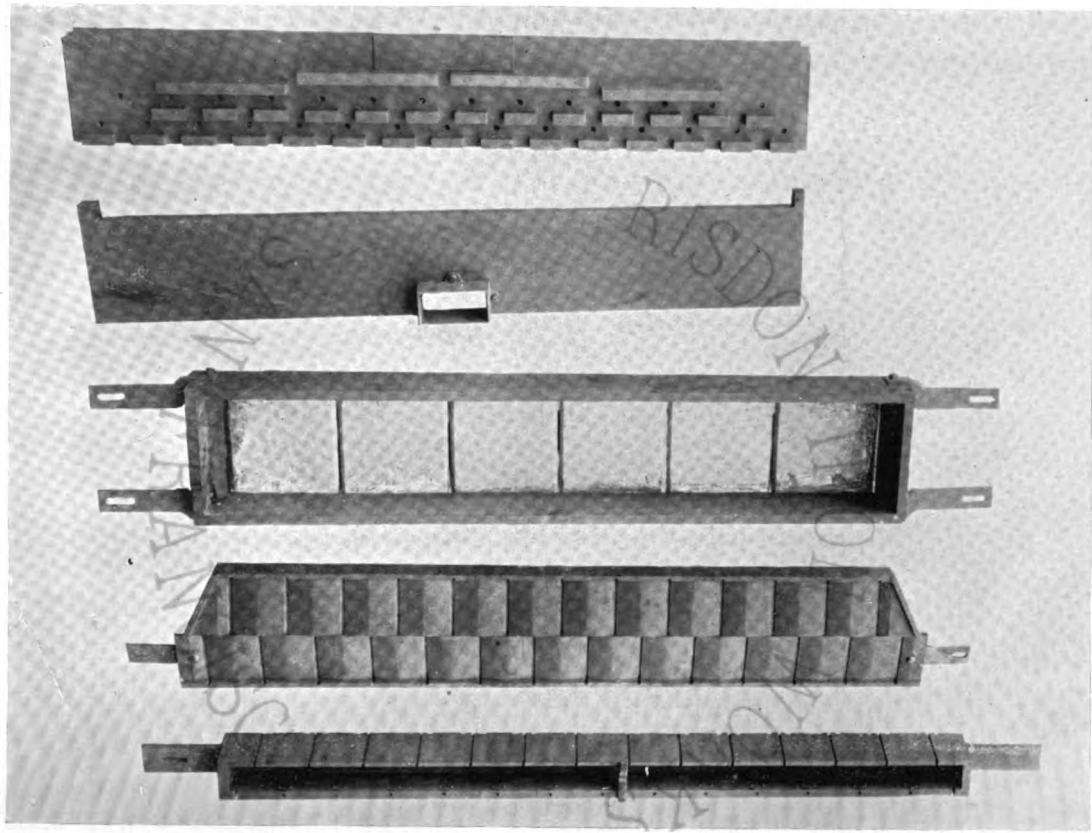


Fig. 9.

Pulley on Concentrator

To make 118 to 120 revolutions per minute. Diameter of Pulley 14″ or 18″ as desired, to suit pulley on countershaft.

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No. 4.--Pulp Distributor Box showing galvanized iron bottom, with ¼'' grooves 10'' apart.
No. 5.—Staggering Board in Distributor.
No. 6.—Cover with opening to receive pulp from battery.
No. 7.—Clear Water Box made fast to main frame.
No. 8.—Distributor made fast to shaking table, receiving its water from Water Box No. 6.

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Pulp Distribution.

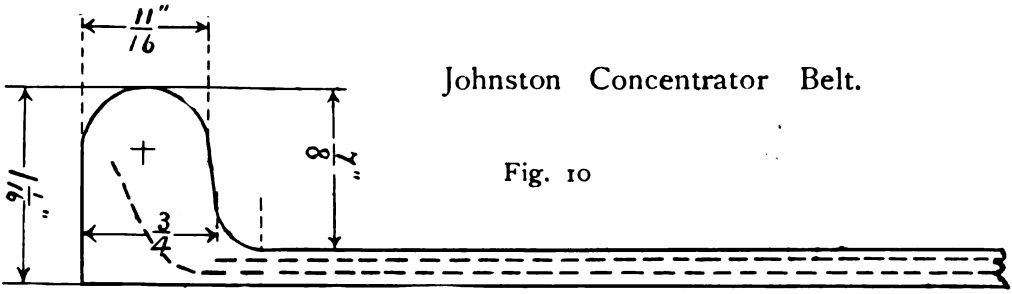
Figure 4 is an illustration of the Pulp Distributor, showing the slots in the bottom ten inches apart, and running parallel to the sides of the belt, by means of which separation is more readily effected than by discharging the pulp across the belt.

Figure 5 shows the staggering device by which the pulp is distributed on the galvanized iron bottom of the distributor.

Figure 6 shows the top of the distributing box with the opening to receive the pulp from the batteries.

Figure 7 is the water box made fast to the frame of the machine, and deposits its water on the distributor which is attached to the shaking frame and moves with it.

Figure 8 is the clear water distributor made fast to the shaking frame of the machine, and receiving its water from the water box, Fig. 6, which is attached to the stationary frame. By this means the falling water removes the smallest possible quantity of sulphurets from the belt.



Johnston Concentrator Belt.

Fig. 10

Full size cut of Johnston moulded edge on rubber belt, used on Johnston Concentrator.

PRICE WITH MOULDED RUBBER BELT.

Six-foot belt machine, including foundation timbers, sulphuret box and everything shown in cut No. 1	$500 00
Four-foot-six-inch belt, the same as above	470 00

(F. O. B. San Francisco.)

To Estimate the Percentage of Sulphurets in Quartz.

Take ten thousand grains or 20.8 ounces of crushed ore which will pass through a forty-mesh wire screen. Wash the ore very carefully in batea or pan, and rewash as long as sulphurets appear. Dry and weigh. Each grain of sulphurets will equal one-hundredth of one per cent. If the sulphurets weigh 175 grains, the quartz contains one and three-fourths per cent of sulphurets, or, if twenty grains, one-fifth of one per cent. If the sulphurets are worth $100 per ton, the value of sulphurets in each ton of ore is $1.75, or, if one-fifth of one per cent, 20 cents per ton.

To test tailings, dry and weigh ten thousand grains. Wash as above. Dry and weigh the sulphurets. Each grain will represent one-hundredth of one per cent, and a loss of 1 cent per ton if the sulphurets are worth $100 per ton. Thus if the ten thousand grains of tailings yield three and one-half grains of sulphurets, the loss is 3½ cents per ton in sulphurets. If the sulphurets are worth $60 per ton, multiply sixty by three and one-half, and 2.1 cents is the value of the sulphurets in one ton of tailings. If they are worth $375 per ton, multiply as above and the value in each ton of tailings is 13.12 cents per ton in sulphurets.

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TESTIMONIALS.

COPIES OF LETTERS.

MR. GEO. JOHNSTON, SAN FRANCISCO, CAL.

Dear Sir:—After a careful examination and a close study of your concentrator while in operation, I do not hesitate to pronounce it, in my judgment, to be the most superior machine in the market. Its durability and simplicity of construction are its first points and are essential ones. The rocker motion immediately settles the sulphurets to the canvas belt, which retains them with any amalgam that may pass the plates. It leaves the sulphurets very clean, retains all the fine sulphurets, and does the work of two Frues running by the side of it.

(Signed) J. L. GRIMES,
Supt. Drummond Mine.

Forest Hill, Cal., March 24, 1893.

RISDON IRON WORKS, SAN FRANCISCO, CAL.

Gentlemen:—I am very much pleased with the work of the Johnston Concentrator. It is handling the pulp from a three and one-half foot Huntington mill and apparently is not working to its capacity. The sulphurets are very clean and the loss in the tailings is insignificant—only a few coarse cubes and flakes (no fine sulphurets).

Our millmen have no trouble with the adjusting of the belt, which frequently runs for more than a shift without adjustment, and any millman can learn to work it perfectly in a few hours—it is simplicity itself.

(Signed) CHARLES REED,
Supt. St. Lawrence Mine.

St. Lawrence Mine, Ophir, Placer Co., Cal., May 6, 1893.

We make the following extracts from a letter dated July 17, 1893, addressed by William Kraft, M. E., Superintendent of the Gold Bluff Mining Company, near Downieville, Sierra County, to C. R. Bowker, Esq., of Seattle, Wash.:

"Result: Each machine taking the pulp from five stamps, tailings assayed trace only After running forty-eight hours, I was so well satisfied that the Johnston was the very best concentrator in the market that I at once ordered the other two machines. After the first two machines had been running a few days, Mr. Johnston stated that, with careful watching, they would concentrate the pulp from ten stamps each, which I doubted very much. However, I let him try it, and the following was the result:

June 19.	Concentrator No. 1—Pulp from 10 stamps, tailings assayed		$1 03
" 19.	" " 2— " " " " "		1 03
" 23.	" " 1— " " " " "		Trace only
" 23.	" " 2— " " " " "		2 06 1/10 (*)

(*) Millman put in some oxidized sulphurets in sluice leading to this one.

June 24.	Concentrator No. 1—Pulp from 10 stamps, tailings assayed		Trace
" 24.	" " 2— " " " " "		1 03
" 28.	" " 1— " " " " "		Trace
" 28.	" " 2— " " " " "		Trace
July 7.	No. 1—Pulp from 5 stamps, tailings assayed		Trace
" 7.	" 2— " " " " "		Nothing
" 7.	" 3— " " " " "		Nothing
" 7.	" 4— " " " " "		Trace
" 10	" 1— " " " " "		Trace
" 10	" 2— " " " " "		Trace
" 10.	" 3— " " " " "		Trace
" 10.	" 4— " " " " "		Trace
July 12 and 13.	Same record.....		! ! !

"I consider this the most wonderful record ever made by any concentrator, hence I cheerfully advocate and advise the adoption of these machines. They deserve all that can be said of them.

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Phœnix Mining Company, { Location of Works, Hurleton, Main Office, Oroville.

Oroville, Butte Co., Cal., July 21, 1893.

MR. GEO. JOHNSTON:

Dear Sir:—We have at last succeeded in surmounting the only difficulty that has presented itself, namely saving the sulphurets. We do this with your new concentrator, which conclusively proves, in my opinion, that it is far superior to any other concentrator known. In fact, I consider it *the only concentrator* now on the market.

It is indeed doing excellent work, perfectly smooth in running gear, simple and sensitive of adjustment, requiring but a minimum of power for its operation, built in every detail on strictly scientific principles, and entirely noiseless in its operation.

Without hesitancy, we highly recommend the Johnston Concentrator.

Very truly yours,

(Signed) PHŒNIX MINING COMPANY,
G. S. COLMAN.

Lucky Bart Mine, Gold Hill, Or., September 16, 1893.

RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO:

Gentlemen:—I have made a careful test by panning, below the Johnston Concentrator, and find the tailings taken every half hour during the day of September 14th to be remarkably clean. One test of 10,000 grains showed a loss of one ton of sulphurets in 7,364 tons of tailings, and another test showed a loss of one ton of sulphurets in 10,674 tons of tailings.

The screens used on the five-stamp battery of 850 pounds each were round punched No. 0 tin screens, and from 10,000 grains 9,562 grains passed through a 60-mesh wire screen, and 438 grains would not pass through a 60 mesh.

The sulphurets are remarkably clear of sand. The rock contained about two per cent. of sulphurets.

Yours respectfully,

(Signed) LUCKY BART MINING CO.
MORTON LINDLEY.

(EXTRACT.)

Gold Bluff Mine, Downieville, Cal., January 24, 1894.

RISDON IRON WORKS:

"The machine has the same monotonous record, *i. e.*, they absolutely save all except traces of sulphurets."

Respectfully,

(Signed) W. KRAFT, Superintendent.

Gold Hill, Or., January 24, 1894.

(EXTRACT.)

RISDON IRON WORKS:

"We take pleasure in advising you that the Johnston Concentrator is still doing excellent work. Mr. J. B. Weston, late of Plymouth, says: 'The Johnston is the most perfect concentrator I ever saw. It is the True improved at last.'"

(Signed) LUCKY BART MINING CO.
MORTON LINDLEY, President.

Phœnix Mine, Butte Co., March 5, 1894.

RISDON IRON WORKS, SAN FRANCISCO:

Gentlemen:—After six months' use of the Johnston Concentrator we find it a very perfect machine; much better than any heretofore used. The wearing parts and canvas belt have not given us a minute delay. The slight side tilt is perfect in equal distribution. Loss in tailings nominal and not worthy of consideration.

(Signed) W. H. RODDA, Superintendent.

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Percha Mine, Hillsboro, New Mexico, March 30, 1894.

"The Johnston Concentrator does its work to perfection."

(Signed) GEORGE S. OLIVER, Superintendent.

California Midwinter International Exposition,
Golden Gate Park Park, San Francisco, Cal., September 5, 1894.

DIPLOMA GOLD MEDAL AWARDED RISDON IRON WORKS ON JOHNSTON CONCENTRATOR.

Extract from report of the General Superintendent to the Executive, Finance and Advisory Committee of the California State Mining Exhibit of the California Midwinter International Exposition:

"I consider that the Committee is under special obligations to Mr. Johnston for the use of his excellent concentrator in our mill, as the same did splendid work, and greatly facilitated the milling of our ore."

(Signed) EDWARD H. BENJAMIN,
General Superintendent.

San Francisco, Cal., June 1, 1894.

THE RISDON IRON WORKS, SAN FRANCISCO:

Gentlemen:—We have tested the Johnston Concentrator furnished us by you on trial; and, after an exhaustive test, we are satisfied it is the best in the market.

Please prepare and ship us, as soon as possible, thirteen more machines.

Yours truly.

(Signed) APOLLO CONS. MINING CO.
By LEON SLOSS.

Bert Langridge, Ph. D., Mining Engineer,
Superintendent Hudson Gold Mining Co, Ward, Colorado, and
Superintendent Gold Quarry Company, Ballarat, Colorado.
Ward, Colorado, June 8, 1894.

RISDON IRON WORKS, SAN FRANCIKCO:

Gentlemen:—After a thorough test of the Johnston Concentrator I am so well satisfied that I wired you to ship me two or more as speedily as possible.

I find the machine well constructed, easily kept in order, requiring but little attention and doing entirely satisfactory work on our ore.

After my experience with other tables I am congratulating myself on my possession of the Johnston. Yours faithfully, B. LANGRIDGE.

[On January 15, 1895, we shipped to Mr. Bert Langridge four more machines for his new mill, which is a further indorsement of them.]

Grass Valley, July 15, 1895.

RISDON IRON WORKS, SAN FRANCISCO:

Gentlemen:—I take pleasure in speaking to you of the Johnston Concentrator. I have run the concentrators for a year and they give the best of satisfaction for the thoroughness of their work. The simplicity of construction, and the ease with which they are regulated, and run with varying degrees of speed and load, place them in my estimation at the head of the belt machines. Respectfully yours,

(Signed) A. F. PERRIN,
Supt. State Ledge Mine.

Yellowstone Mining Co.,
Bear Valley, Mariposa Co., Cal., April 5, 1895.

RISDON IRON WORKS, San Francisco, Cal.:

Gentlemen:—We are well pleased with the Concentrator. It saves the sulphurets clean and close; from assay of sand made they only found a trace of sulphurets.

Yours,

YELLOWSTONE MINING CO.,

(Signed) C. H. BURT, Superintendent.

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LETTERS CONTINUED.

The Gold Valley Mining Co. of San Francisco,
Mission San Jose, Cal., October 17, 1895.

RISDON IRON AND LOCOMOTIVE WORKS, San Francisco, Cal.

Gentlemen:—We take pleasure in having to inform you that, after a careful investigation extending over six weeks' steady run alongside of six other concentrators, the Johnston which you put in for us was the only machine from which you could not find a loss in the tailings It has done all you claim for it, and has proved more than satisfactory. We intend replacing all other concentrators with Johnston's, as we are convinced they will pay for themselves many times over in a year.

CHAS. C. MCIVER, President.
D. CUSHMAN, Secretary.

Bullion-Beck and Champion Mining Company,
Eureka, Utah, August 24, 1895.

THE RISDON IRON AND LOCOMOTIVE WORKS, SAN FRANCISCO.

Gentlemen:—In February last, in connection with the ffve-foot Bryan Roller Mill which we took from you to test in competition with the Huntington Mill, we also took a six-foot Johnson Concentrator to be tested with ten Frue's, one end shake with four belts, and one side shake Woodbury. We have been working these machines since the mill was completed at such times when we had sufficient water.

The terms on which the test was made was that the machine doing the most satisfactory work should be accepted and the others taken out. This did not apply to the Frue, as they were purchased with the plant. In compliance with the agreement, we now inform you that the Johnston Concentrator has proved so superior over the other machines that we now order from you four more of the Johnston Concentrators.

Yours truly, JOHN BECK, President.
SIMON BAMBERGER, Director.
W. J. BEATIE, Secretary.

SEND FOR CIRCULARS.

EXTRACTS FROM TESTIMONY TAKEN BEFORE COURT COMMISSIONERS IN THE CIRCUIT COURT OF THE NINTH JUDICIAL DISTRICT.

Thomas Clay Mayon, Superintendent of the Apollo Consolidated Mining Co., Unga Island, Alaska, being sworn, said :

A. 7. The ore contains copper, lead, zinc, and gold and silver.

Q. 34. Was that Johnston Concentrator put in the Apollo Mill? A. Yes.

Q. 35. In the mill in which the Frue Concentrator was running? A. It was; yes, sir.

Q. 36. Did you make a test of the two? A. I did.

Q. 37. Was it a fair and impartial test? A. So far as could be made, it was; yes, sir.

Q. 38. Did you have any other object in making the test than to determine fairly and impartially what were the merits of the concentrator? A. None whatever.

Q. 39. And you made that kind of a test, did you? A. Yes, sir.

Q. 40. In the interest of your company? A. In the interest of my company, of course; yes, sir.

Q. 41. What was the result of that test? A. Well, the result of the test after a month's run with the Frue vanners, we had ten stamps, two Frue vanners and one Johnston Concentrator. The pulp was taken out of the ten stamps equally—as equally as it could be by dividing the boxes between the three concentrators. The pulp or ore was assayed, sampled

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and assayed daily as it passed into the battery from the ore bins, and the tailings from the two Frue vanners assayed daily, and the tailings from the Johnston Concentrator also daily, and separately, of course. The product from the Johnston Concentrator was saved separately from that of the Frue vanners, and that was assayed daily. At the end of the month, after a month's test, my assayer figured up the percentage gained from the ore on the Frue vanners and the percentage gained from it on the Johnston Concentrator. The result was seventy-two per cent. of the assay value of the Frue, and eighty-one per cent. of the assay value of the ore on the Johnston.

Q. 42. I presume by that you mean the Frue vanners saved seventy-two per cent. of the assay value of the pulp that passed over it? A. Yes; of the pulp that passed over it.

Q. 43. And that the Johnston saved eighty-one per cent. of the pulp that passed over it? A. That is the calculation.

Q. 44. Were you satisfied with the test that was made? A. I was satisfied; yes, sir; perfectly.

Q. 45. Did you or your company buy any more concentrators after that? A. We did. The next year after making the test, I came down to San Francisco, and we put in thirty more stamps in our mill and thirteen more Johnston Concentrators.

Q. 49. Did you make any test between the two machines as to the capacity? A. Well, yes, sir; I made a test as to the capacity during that month between the machines.

Q. 50. Just state what that test was. A. Well, of course, I could not give the exact amount of pulp that I run over each of them at the time I made those tests, but I should suppose that for two or three days out of the month I ran pulp over the Johnston Concentrator, all that would be produced from five stamps of a ten-stamp mill, and the other from the other five stamps was divided over the Frue vanners, was what was coming from five stamps, what I supposed would be about the proportion coming from five stamps divided as accurately as we could get the pulp coming from them. And the other five stamps were divided between the two Frue vanners.

Q. 51. So that half of the product of your ten stamps was running on to the one Johnston Concentrator, and the other was running on to the two Frue concentrators? A. That is the idea.

Q 52. What was the result? A. The result was that our assays from the tailings of the Johnston Concentrator during these tests—of course, they were not all made one day following the other, but different times during the month—the tailings from the Johnston Concentrator, as near as I can remember, was about 30 cents, where the tailings from the Frue vanners on the same days were 40 odd cents. I disremember the exact figures, but it was some 10 or 15 cents difference from the Johnston Concentrators.

Q. 53. Did the Johnston Concentrator have any trouble in handling that large amount of pulp? A. None whatever.

Q. 54. What difference did you note in the mechanical operations of the Frue Concentrator and the Johnston Concentrator? What difference was there mechanically? A. Well, in the mechanical operations of the machines there is considerable difference. The Johnston Concentrators are slung with arms from above on an angle, giving it an oscillating motion. From those arms hung at an angle above, the Johnston Concentrator has that oscillating motion.

Q. 55. The Johnston Concentrator, then, moved with an oscillating motion while the Frue moved with a straight side motion? A. A straight side motion; yes, sir.

Q. 56. And that was the mechanical difference between the two machines? A. In the working of the two machines; yes, sir.

In the same suit, Mr. Daniel Crotty testified that at the Anglo-Mexican Mine, at San Jose de Garcia, in the State of Sinaloa, Mexico, where he had charge of four Frues and four Johnston Concentrators, as Master Mechanic, that the Johnstons saved seven to nine per cent. more than the Frues. There were four Frues and four Johnstons in the mill.

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Johnston Concentrator—Number of Parts.

1—Corner Post Head, right side.
2—Corner Post Head, left side.
3—Corner Post Foot, right side.
4—Corner Post Foot, left side.
5—1 12″ Galvanized Iron Drum.
6—1 12″ Galvanized Iron Drum.
7—1 8″ Galvanized Iron Drum.
8—1 6″ Galvanized Iron Drum.
9—1 12″ Galvanized Iron Drum.
10—1 Bracket carrying two 12″ rollers.
11—1 Bracket, right side, carrying gear wheel, screw gear, etc.
12—1 Bracket carrying 8″ roller.
13—1 Bracket carrying 8″ roller.
15—2 Brackets for 6″ carrying roll.
16—1 Gear Wheel.
17—1 Gear Screw.
18—1 Oil Box for screw gear.
19—2 Couplings on wire rope.
20—1 Bearing for worm wheel.
21A 6 Brass Bearings.
22A 2 Brass Bearings with set screw.
23—1 Bracket supporting water distributor, right side.
24—1 Bracket supporting water distributor, left side.
26—1 Supporting Bracket for pulp distributor.
27—Bracket to carry pulp distributor.
28—Upright supporting pulp distributor.
29—Bracket to carry water distributor.
30—Horizontal Bracket to carry pulp distributor.
32—Horizontal Bracket to carry pulp distributor.
33—1 Pipe Bracket for water pipe to water box.
34—Saddles carrying 2″ roller next head of table.
35—24 Russia Iron Caps for 2″ rollers.
36—Saddles carrying second 2″ roller from head of table.
37—2 Wrought Iron Brackets for water box.
38—Sadules carrying third, fourth, fifth, sixth, seventh, eighth, ninth, tenth, eleventh, twelfth and thirteenth rollers.
39—Hand Screw on bracket No. 37.
40—12 2″ Brass Carrying Rolls.
41—Water Box.
42—Clear Water Distributor.
43—1 Eccentric at head of table.
44—Pulp Distributor.
45—1 Eccentric at foot of table.
46—4 Carrying Caps on top of posts.
47—2 Collars on 2″ shaft.
48—4 Hangers or Links.
49—1 small Cone Pulley.
50—2 Stretcher Braces from posts to foundation frames.
51—1 Cone Pulley, large.
53—1 14″ Balance Wheel Pulley.
55—2″ g Shaft.
56—2 Clamps on gas pipe No. 54.
57—2 Wire Cables.
58A 2 Brass Brackets carrying roll No. 9.
59—1 Tightener Bracket.
60—1 Hand Screw for adjusting belt.
61—Adjusting Screw on tightener.
62—2 Hinges Bolted to Channel Iron by which Shaking Frame is suspended.
63—Crank on adjusting screw of belt tightener.
64—Square Cast-iron Box on pulp distributor.
65—2 Leather Belts for cone pulleys.
68—1 Sulphuret Tank.
69—2 Hinges bolted to channel iron by which shaking frame is suspended.
71—8 1¼″ Lock Nuts.
73—Central distance Gas Pipe and Bolt.
77—1 piece ⅝″ Distance Rod, 2 nuts on each end.
79—1 piece Tightener Bracket.
81—1 Tightener.
83—1 Roll for tightener.
85—4 Jack Screws.
86—4 Socket Washers for same.
87—4 C. I. Steps for Elevating Screws.
93—1 piece 3′ Rubber Hose, 2″ diameter.
94—1 14″ Screw Driver.
95—1 Double-end Wrench, 34.
96—1 Double-end Wrench, 27.
98—1 ½″ Brass Socket Wrench.
99—1 Rubber Belt, Johnston molded edge.
100—2 ⅝x5″ Lag Screws.
101—1 ½x3″ Lag Screw.
102—18 ⅝x9″ Bolts, Nuts.
103—2 Spring Steel Pitmans, ⅜x2′x5′
104—2 large ¼″ Oil Cups.
105—3 small ¼″ Oil Cups.
106—2 Compression Grease Cups for eccentrics.

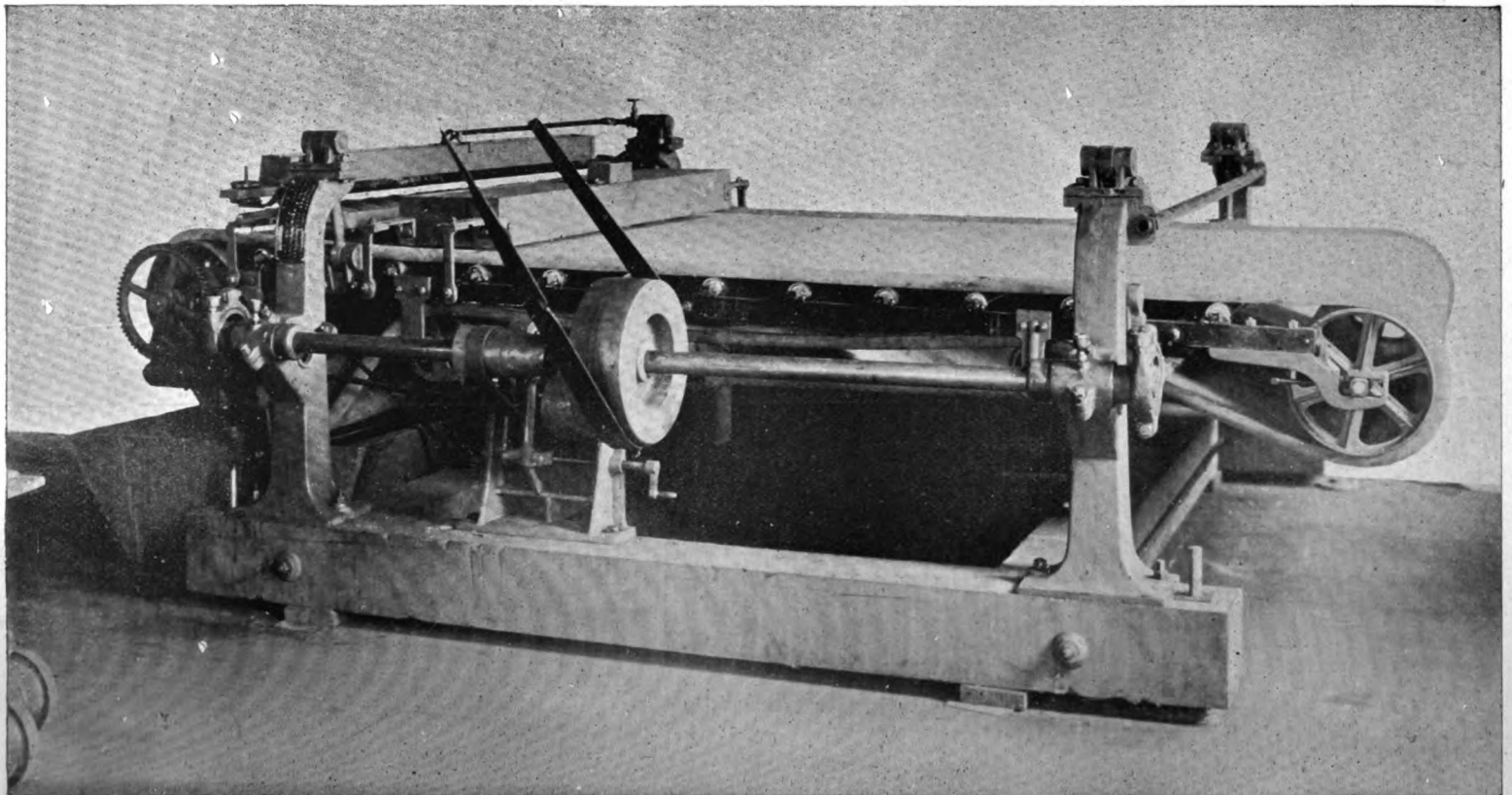
Pipes and Pipe Fittings.

31—3 Elbows, ½″
52—½″ Pipe carrying water to water box, 4′
54—2 Gas Pipes with Clamps to which Pitman straps are attached.
66—2 pieces, 1¼″ pipe, 7′ 1″ Stay Pipe.
67—1 Perforated Spray Pipe.
70—Perforated Gas Spray Pipe.
72—3 ½″ Globe Valves.
74—2 ⅜″x9′ Guy Rods.
75—1 piece Gas Pipe ½x19″
76—1 piece Gas Pipe ½x7″
78—2 pieces ½x2″
80—1 piece—1¼x3″ Nipple.
82—1 piece Gas Pipe 1¼″x4.
84—1 Reducer, ½x½x¼″
89—1 1¼″ Elbow
88—2 1¼″ Lock Nuts.
90—1 1½x3″ Nipple.
91—1 2″ to 1½″ Reducer.
92—2 pieces ½x5″ Gas Pipe.

Extras.

½ doz. ½″ Washers.
⅛ doz. ½″ Nuts.
4 ⅜x1¼″ Bolts and Nuts.
1 doz. Belt Hooks.
2 doz. 16-18x⅜″ Round-head Machine Screws.
½ doz. ⅜″ Washers.
⅛ doz. 1″ Washers.
½ doz. ⅜″ Washers.
4 ½x3″ Set Screws.
1 2″ Brass Carrying Roll.

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Johnston Concentrator, Risdon Iron Works, Sole Manufacturers.

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CATALOGUE No. 15

2nd EDITION.

Gold Dredging Machinery

BUILDERS OF

Risdon Water Wheels "Pelton Type"
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RISDON CONCENTRATOR (True Type)
MILLING MACHINERY
JOHNSON CONCENTRATORS
GOLD DREDGING

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Of Practical Value

Editorial reproduced from *Mining and Scientific Press* of Sept, 11, 1897.

In an article in the issue of September 4th, Mr. Postlethwaite tells of New Zealand river dredging for gold, giving some practical pointers on what has proved to be a valuable method, and modestly suggests that while California can teach the rest of the world a good deal about gold mining, this is one of the methods in which another gold-producing section of the globe can teach California. Costly experience and effort in New Zealand have evolved a system of river dredging which California can note and follow with profit. The inventive California miner has in the last fifty years produced a great many devices that others, elsewhere, have adopted, but this State has no feeling of self-sufficiency, and gladly gains from any and every source anything of practical value. While there is no corner of the globe where gold mining is carried on that a California device is not found, yet "everybody is wiser than anybody," and collective genius is needed to solve the many hard problems encountered in mining gold.

There are miners who know it all; who cannot be told anything; who have learned everything, and have reached perfection. Such degree of knowledge is sometimes manifested by millmen, and to hint that their methods and practices might be improved, would not to their ideas be orthodox. But such hide-bound operators are, fortunately, few, and California possesses a very small percentage of them. It is only by interchange of ideas, publication of experience and result of experiment that general knowledge can be secured. Science is simply organized knowledge, and is resultant on such articles as that furnished in this journal by Mr. Postlethwaite. For nearly thirty-eight years this paper has encouraged the publication of such articles written by men who know what they are talking about, and it is believed that the means of intercommunication thus afforded those who guide and control the operation of mines, mills and mining systems the world over has, more than anything else, aided in the progress of scientific mining. The thousands of technical and descriptive articles on different mining matters published herein constitute a record of experiment, experience and practical knowledge unequaled elsewhere, and any communication from a practical mining man is always gladly given the prominence that its merits warrant.

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NOTICE

We beg to notify the mining public that we have purchased the patents and right of building Mr. R. H. Postlethwaite dredges; also the improved form of Gold Tables and Riffles.

We are aware of the claims made by other manufacturers as to their patents. *We infringe none and do not propose that others shall infringe ours.* We shall be glad to quote prices for dredges complete, set up and in running order, on receipt of particulars.

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River Dredging for Gold

Written for the *Mining and Scientific Press*

BY

R. H. Postlethwaite, Memb. Inst. Electrical Engineers, England.

REGARDING river dredging for gold, I find from my own observation, and also from the letter written by Mr. Richards in the issue of the *Mining and Scientific Press* of June 12th, that so far subaqueous mining has not been a success in this State. I have read Mr. Richards' letter with great interest, and fully endorse his remark that successful dredging must be the result of mechanical skill and "evolution." This evolution is exactly what I claim for the class of dredges I am now designing, and which are being built by the RISDON IRON WORKS.

A brief resumé of dredging, as carried out on the River Molyneux in New Zealand, where they are now working some sixty dredges, will show the evolution process. It is a very swift river; carries more water than the Sacramento, and the bottom is composed of a layer of barren tailings varying from one to twenty feet deep, and traveling at varying velocities; then comes the old formation of boulders and gravel interspersed with seams of pay dirt. As there is an immense amount of gold in the bed of the river, it was at once recognized that means must be found to handle it. In the early days the miners worked the bank as far in the river as they could reach with spoon dredges. The next evolution was a small, weak, and poorly-constructed bucket-ladder dredge driven by current wheels on either side. These proved very inadequate to handle the heavy boulders, and were only able to work in the current. The next step was to make the machinery heavier and put on a steam engine. It was about this time that the use of the spud—in New Zealand called a sett—came in, but did not last very long, as it was found inefficient and took more hands to work it. *The spud is not found now on any dredge in the country*, being quite out of date. In place of the spud the best dredges use a power winch with six drums, all being under the control of one man. Four of these drums carry lines running from the four corners of the dredge, the other end of the line being affixed to "dead men," or backers on the beach. The fifth drum carries the head line. With these five lines the dredge can be made to rapidly take up any position necessary, one man handling her with the greatest ease and nicety, and with no loss of time. The sixth winch barrel carries the ladder line, raising or lowering the ladder as necessary. For lifting the large quantities of gravel, rock and boulders, after long and thorough

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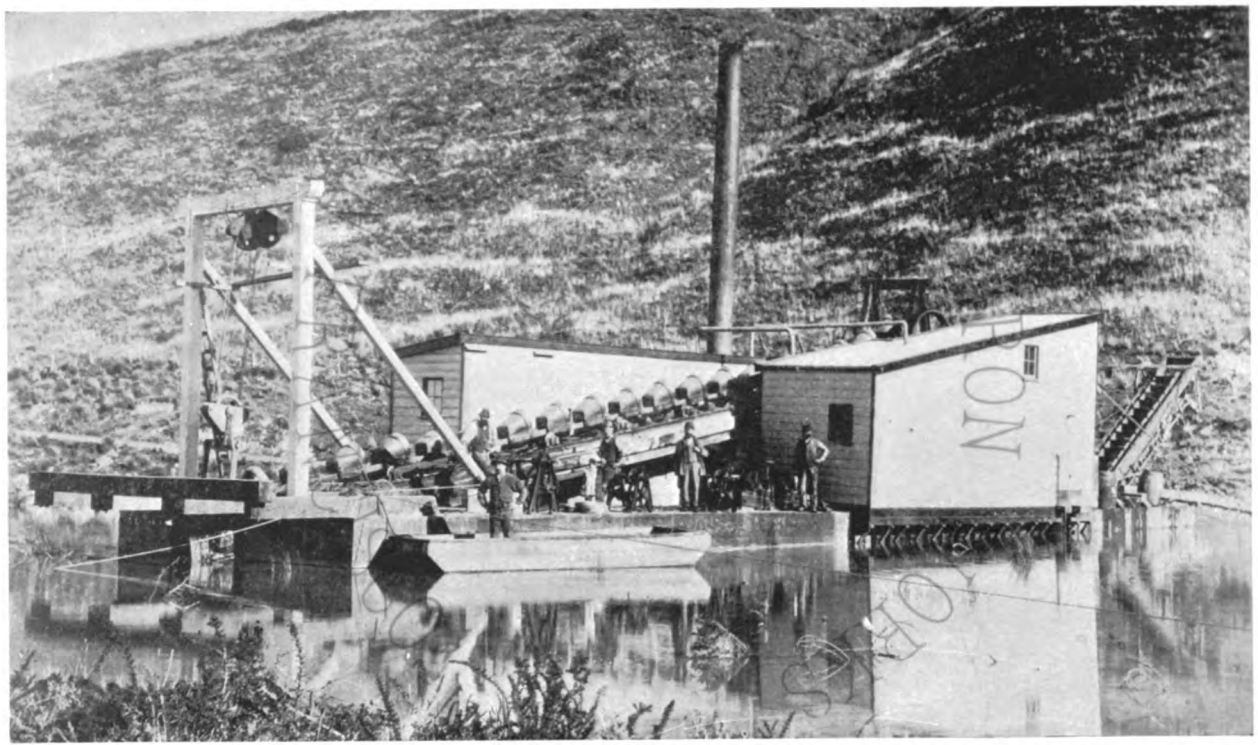
trials, it has been found that the bucket-ladder will easily beat the centrifugal pump. The pump dredge was given a very fair test—different makes of pumps being used—but all attempts ended in failure. The failure arose from two causes—first, lack of efficiency. Mr. Richards, who is a leading authority on centrifugal pumps, will bear me out that directly you design a pump to carry large stones, you do so at the loss of efficiency. In the seeond place, unless boulders up to one ton in weight could be handled, a machine was useless in the Molyneux.

For sand or slurry the centrifugal pump, I at once admit, is the thing; but not for gold dredging. Two other methods have been tried—one the pneumatic caisson. This would be all right for a rich patch, the locality of which was exactly known; but for regular every-day work, where much barren stuff had to be lifted, it proved a lamentable failure. The last method was the hydraulic elevator—a most excellent appliance in its place, but this place is not in a river bed forty feet below the level of the water, as most of the work of the elevator then consists in pumping water which does not carry gold. The successful gold dredge of the present day is the evolution of thirty odd years, each dredge built being an improvement on the predecessor. No man can sit down and design a dredge by calculations, the strains the machine is subject to being so variable and impossible to accurately fortell. The main shafts of the present dredges are made at least twice as heavy as would be arrived at if calculated to transmit the average horse power used. These sizes have been arrived at by gradually enlarging until a size has been found which will resist the heavy shocks the dredge is subject to. I am now building a dredge on the Yuba River to dredge forty-five feet deep, with a gross capacity of ninety-three cubic yards an hour. The dredge consists of two long pontoons, each 96 feet long by 9 feet beam. These are connected at the stern by a small pontoon 17 feet long and 5 feet wide, the bow being connected by a heavy overhung beam. This practically makes one boat 96 feet long, 23 feet wide, with a well-hole 5 feet wide, running through the center for some 75 feet.

The ladder, 67 feet long, built up as a heavy lattice girder, is hung at the stern end by a bar fixed across a heavy wooden framing. The lower end of the ladder carries a five-sided tumbler, and is suspended by blocks and tackle to a cross-beam. By means of wire rope and blocks the winch can raise or lower the bottom end as required. The top tumbler is carried by the timber framing some three feet above the top end of the ladder. The continuous bucket chain comes up the top side of the ladder on rollers round the top tumbler and back in a catenary curve to the lower tumbler. The top tumbler is driven through a rope transmission and heavy gears by the engine, a vertical compound condensing one which also drives the pump, and indicates about 35 H. P.

The material discharges from the buckets into a delivery plate, down which it shoots into a revolving screen or grizzly. The centrifugal pump, throwing 3000 gallons per minute, supplies water to a perforated pipe inside the screen. This water thoroughly washes the material, the finer wash dirt and gold going through holes in the screen and falling into a distributing box. From the distributing box it passes on to a set of gold-saving tables, 11 feet wide, and thence into a flume. In this connection I would like to point out that the experience in New Zealand leads us to get the greatest width of table practicable, thus running the wash dirt over it in a thin or shallow stream, whereas the general practice here seems to be to use a narrow, long flume. A wide table, with frequent drops and changes of

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IMPROVED RIVER GOLD DREDGER

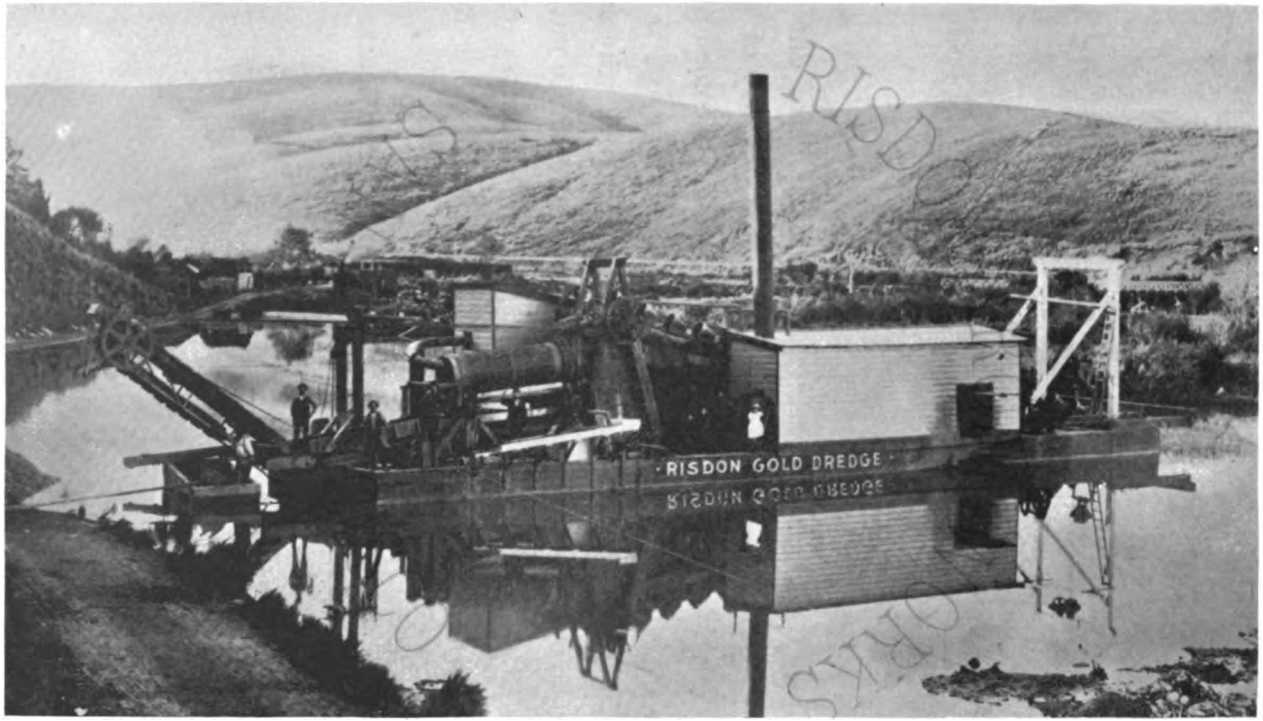
Capacity, 2000 yards per day

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velocity of the stream, together with fairly frequent washing up, is, I feel satisfied the secret of saving fine gold when mixed with much black sand. The tables are covered with cocoa matting and expanded metal, a finer gold saver than which was never used. The stones and rocks pass through the screen down a stone shoot, either direct into the river or onto a tailings elevator, when working into a high face of gravel. It is now in place to consider the class of ground that can be worked with a dredge and the cost per yard of handling the same. Broadly speaking, any ground which is not deeper than 60 feet below water level, or more than 20 feet above, and which contains boulders of not more than say one ton weight, can be handled at from 3 to 5 cents per cubic yard. The ground need not be in a river, provided the seepage is sufficient to float the dredge and keep the water clean enough to wash the dirt with. I think I can say with confidence there is no other method by which ground, provided it fills the above conditions, can be handled so cheaply.

I have felt a little diffident as to writing the above, as I fear some of your readers may say: "What right has a man from a little country like New Zealand to come here and tell us that their knowledge is much greater than ours." In very many ways California is well in advance of New Zealand, especially in quartz milling, and I have learnt much since I came here; but in this one particular class of mining, viz., dredging for gold, I do claim, and with justice, that New Zealand has had more experience than all the rest of the world, and if any of your numerous readers will do me the honor of coming to see the dredge on the Yuba when working, they will be ready to admit that it does all I claim for it. There is, I believe, in California, an immense area of country which can be profitably worked by the above method, and anything which keeps the miner in California is a general and direct benefit to the State.

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IMPROVED RIVER GOLD DREDGER

Capacity, 2000 yards per day

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Capacity of Dredges

We have frequent enquiries as to the capacity of our Dredges.

The gross capacity is 2500 cubic yards per day of 24 hours, counting that there is no delay and that the buckets come up full. In practice we find that 2000 yards is about an average and this is what we consider our dredge will handle. We are asked why we do not build larger sizes and will say the capacity is entirely governed by the *spaces at our disposal for gold saving*, and at 2000 yards we can do better work, make a closer saving and handle our Boat more economically.

If you wish to handle larger quantities buy two boats.

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GOLD DREDGE ON YUBA RIVER

Handling 2000 yards per day at a cost of 3 cents per yard

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Our Patent Power Winch

A great deal of the economy of operating our dredges is due to the design of this winch, which carries seven barrels. These barrels are independent and under the direct control of one man, who by means of levers and clutches, can raise or lower the ladder and readily move the dredge into any acquired position.

Our Patent Tailings Elevator or Stacker

This appliance makes it possible to work by the dredging process banks that are 20 feet above water line, the elevator carrying the tailings far enough from the stern of the boat to keep the water space clear. The elevator is built of steel I beams which carry a continuous chain of buckets. The I beams are strongly bolted to the hull and are supported at the outer end by stays.

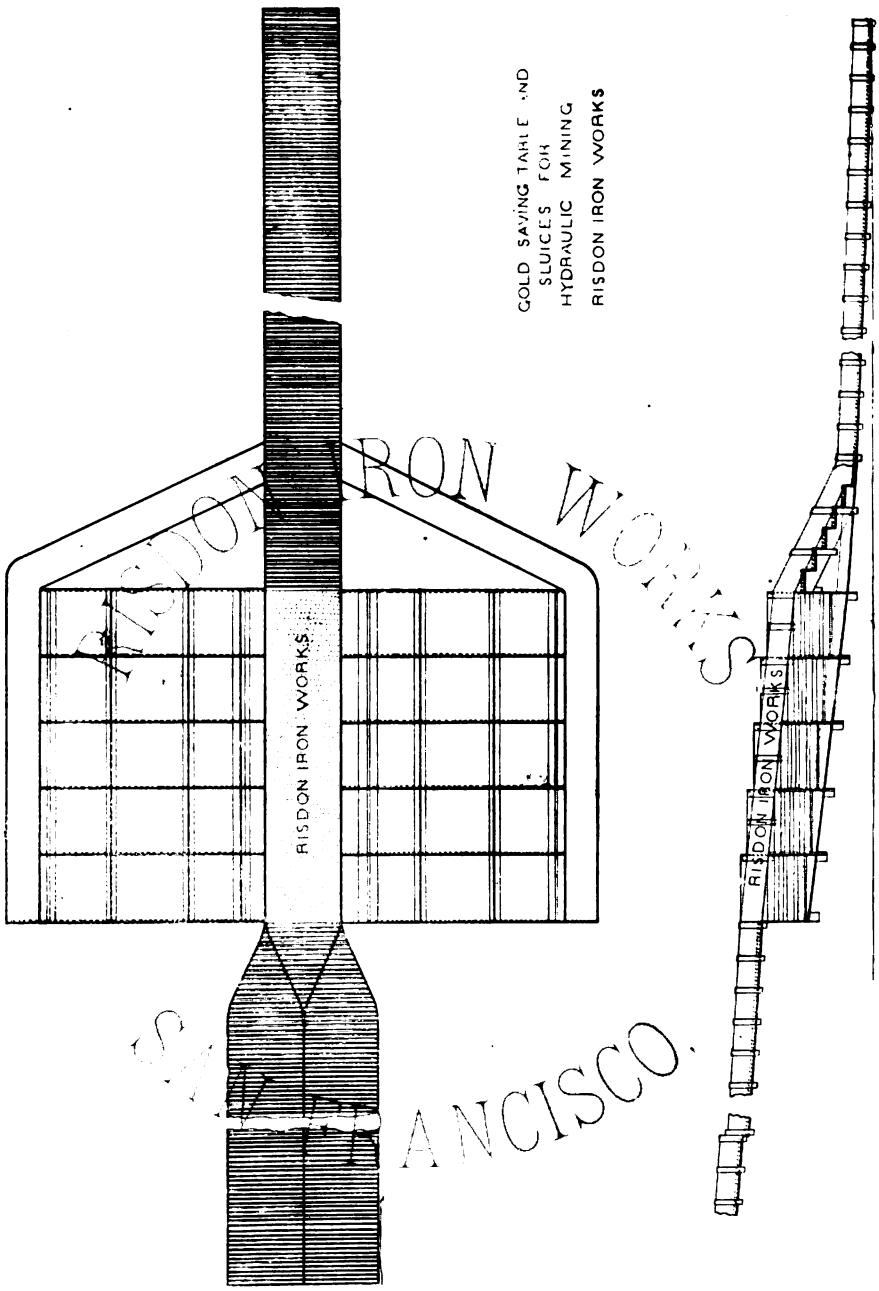
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"RISDON" IMPROVED GOLD DREDGE

Handling 2000 yards per day at a cost of 3 cents per yard

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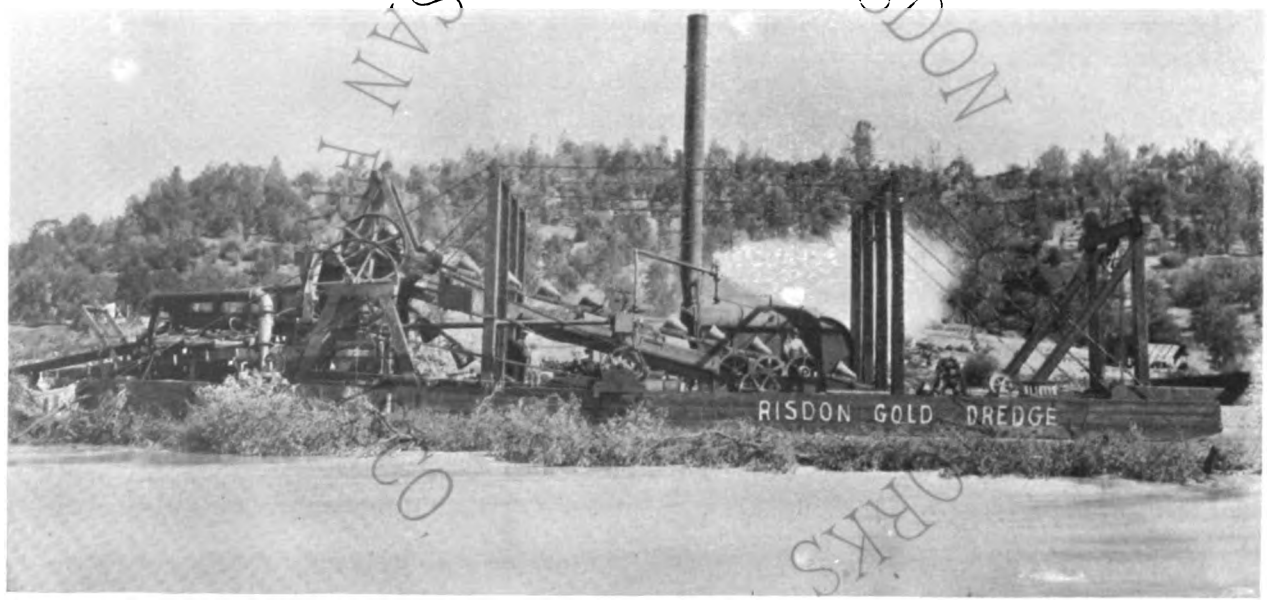


PATENT GOLD-SAVING TABLES

This design is changed to adapt it to the varying conditions of river and paddock dredging.

This illustrates our Patent Gold-saving Tables and we modify the design to suit requirements. It is arranged to be cleaned up in sections and the tables are covered with mats of cocoa matting and expanded metal. The sluce by our Patent Riffles. When we use stacker on boats the sluces run from both sides of the tables over the stern. Our distributing box is arranged with doors which are adjustable and distribute the gravel or sand in light streams over the table.

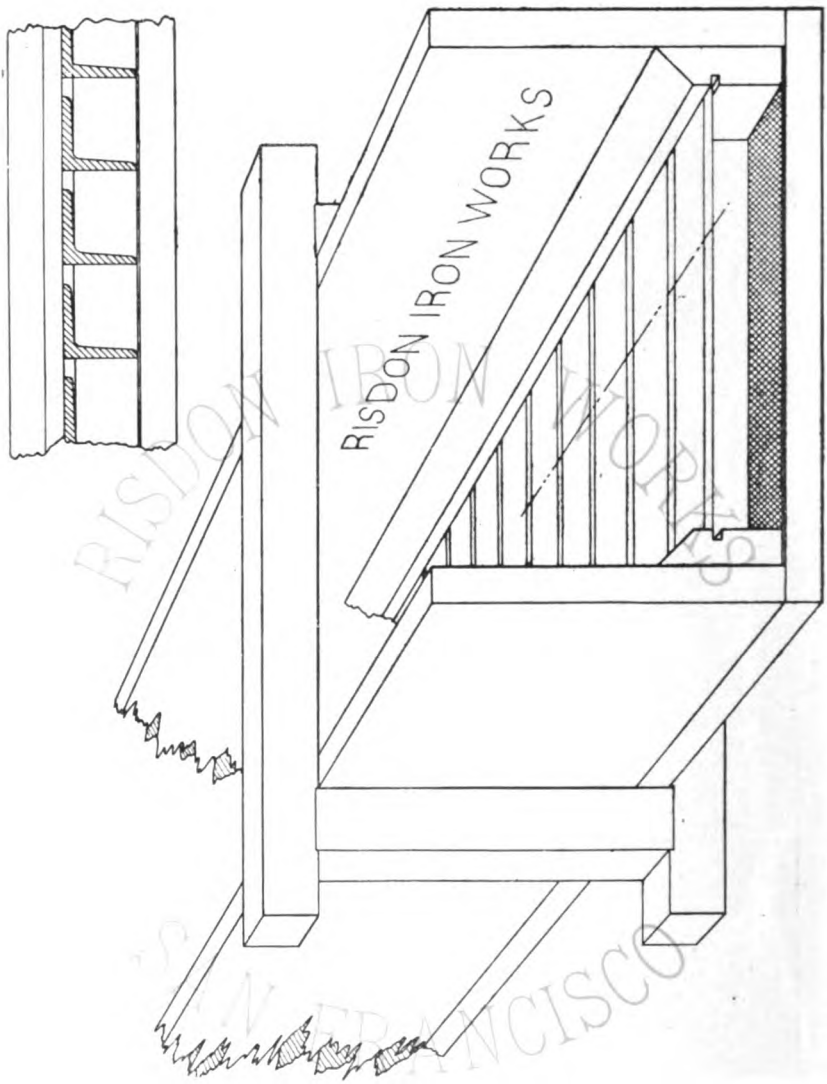
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GOLD DREDGING ON YUBA RIVER

Handling 2000 yards per day at a cost of 3 cents per yard

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PATENT RIFFLE FOR DREDGER

PLATE NO. 12.

PATENT RIFFLES

Plate No. 12 illustrates our improved patent riffles, which we consider the finest gold-saving riffle ever invented, and we recommend their use. They are made of angle or T iron, with cast-iron sides, in two-foot sections, any width; they are easily removed, and when set on cocoanut matting save the very finest flour gold. The section will show the mode of construction.

The iron riffle is a great improvement over the old wood or stone riffle.

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GOLD TABLE

FOR DETERMINING THE

Value of Free Gold per Ton (2,000 lbs.) of Quartz or Cubic Yard of Gravel

PREPARED BY

MELVILLE ATWOOD, F. G. S., Consulting Mining Engineer

Weight, Washed Gold 4-lb. Sample Grains	Fineness 780 Value per Oz. $16.12	Fineness 830 Value per Oz. $17.15	Fineness 875 Value per Oz. $18.08	Fineness 920 Value per Oz. $19.01
5 grains	$83.97	$89.36	$94.20	$99.05
4 "	67.18	71.49	75.36	79.24
3 "	50.38	53.61	56.52	59.43
2 "	33.59	35.74	37.68	39.62
1 "	16.79	17.87	18.84	19.81
.9 "	15.11	16.08	16.95	17.82
.8 "	13.43	14.29	15.07	15.84
.7 "	11.75	12.51	13.19	13.86
.6 "	10.07	10.73	11.30	11.88
.5 "	8.40	8.93	9.42	9.90
.4 "	6.71	7.14	7.53	7.92
.3 "	5.03	5.36	5.65	5.94
.2 "	3.36	3.57	3.76	3.96
.1 "	1.68	1.78	1.88	1.98

Explanation of Table

The foregoing table furnishes an exceedingly simple method of determining the value of *free gold* in a ton of gold-bearing quartz, or a cubic yard of auriferous gravel.

Take a sample of four pounds of quartz; pulverize it to the usual fineness for horning; wash it carefully by batea or other means; amalgamate the gold by the application of quicksilver; volatalize the quicksilver by blow-pipe or otherwise; weigh the resulting button, and the value given in the table opposite such weight will be the value in free gold per ton of 2,000 pounds of quartz.

EXAMPLE

Sample of four pounds produces button weighing one grain, the finest of the gold being 830; then the value of one ton of such quartz would be $17.87.

If the sample of four pounds should produce a button weighing say two and four-tenths grains, then the value of such quartz would be (875 fine) as follows, viz:

Opposite 2 grains.....875 fine.....value $37.68
" 4-10 grains.....875 " ..... " 7.53

Total value per ton (2,000 lbs.).....$45.21

Gold Value of a Cubic Yard of Gravel

To determine the gold value of a cubic yard of auriferous gravel, the foregoing table can be used.

Take a sample of sixty pounds of gravel; pulverize it, and carefully wash it by batea, pan or otherwise; amalgamate the gold; volatalize the quicksilver; weigh the button, and in column in foregoing table, opposite the weight, will be found the gold value of a cubic yard of the gravel.

EXAMPLE

Sample of sixty pounds produces button weighing one grain, the fineness of the gold being 780; then the value of one cubic yard of such gravel would be $1.67. This is arrived at by pointing off one point, or dividing the value given in table by 10.

If the sample of sixty pounds yields a button weighing one and two-tenths grains, then the value of the gravel per cubic yard would be—gold being 920 fine—as follows:

Opposite 1 grain.....920 fine.....value $1.98
" 2-10 grain.....920 " ..... " .03†

Total value cubic yard.....$2.01†

This table is prepared upon the following basis of weights, viz: A sample of four pounds of quartz is the five-hundredths part in weight of a ton of 2,000 pounds, and the gold values given are reduced to this proportion.

Eighteen cubic feet of gravel in bank will weigh one ton, or 2,000 pounds, and a cubic yard, or twenty-seven cubic feet, will weigh 3,000 pounds, or 1½ tons; and sixty pounds being the fiftieth part of the weight of a cubic yard, then the relative proportion of the weight of quartz to gravel is as 50 to 500, or 1 to 10.

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For Working Placers When Water Power is Available

In situations where there is not sufficient water to float a dredge, or where the boulders are too large for that system and the water power available, we recommend the Evans' System. (Send for Catalogue No. 5.)

This system will be advantageously used where there is not sufficient grade to carry off tailings from the Giants, and will be found a very useful and economical system.

We illustrate a view of such a plant in operation.

Prices of Dredges

We are unable to give catalogue prices on Dredge as these vary so owing to the local conditions, in most cases requiring special alterations. To meet them satisfactorily, when asking for figures kindly give the following information:

1. Depth to bedrock from water level.
2. Height of bank, (if any) above water.
3. Depth of water.
4. Nature of gravel or wash dirt.
5. Nature of bedrock.
6. Nature of gold to be saved.
7. Nearest railroad depot.
8. Cost of handling from depot to ground.
9. Cost of lumber delivered on ground.

Owing to the many details to build boat to suit different requirements and prevent failure from lack of knowledge we prefer to build Dredge complete and turn same over in running order.

Our terms are CASH during progress of work.

RISDON IRON WORKS SAN FRANCISCO.

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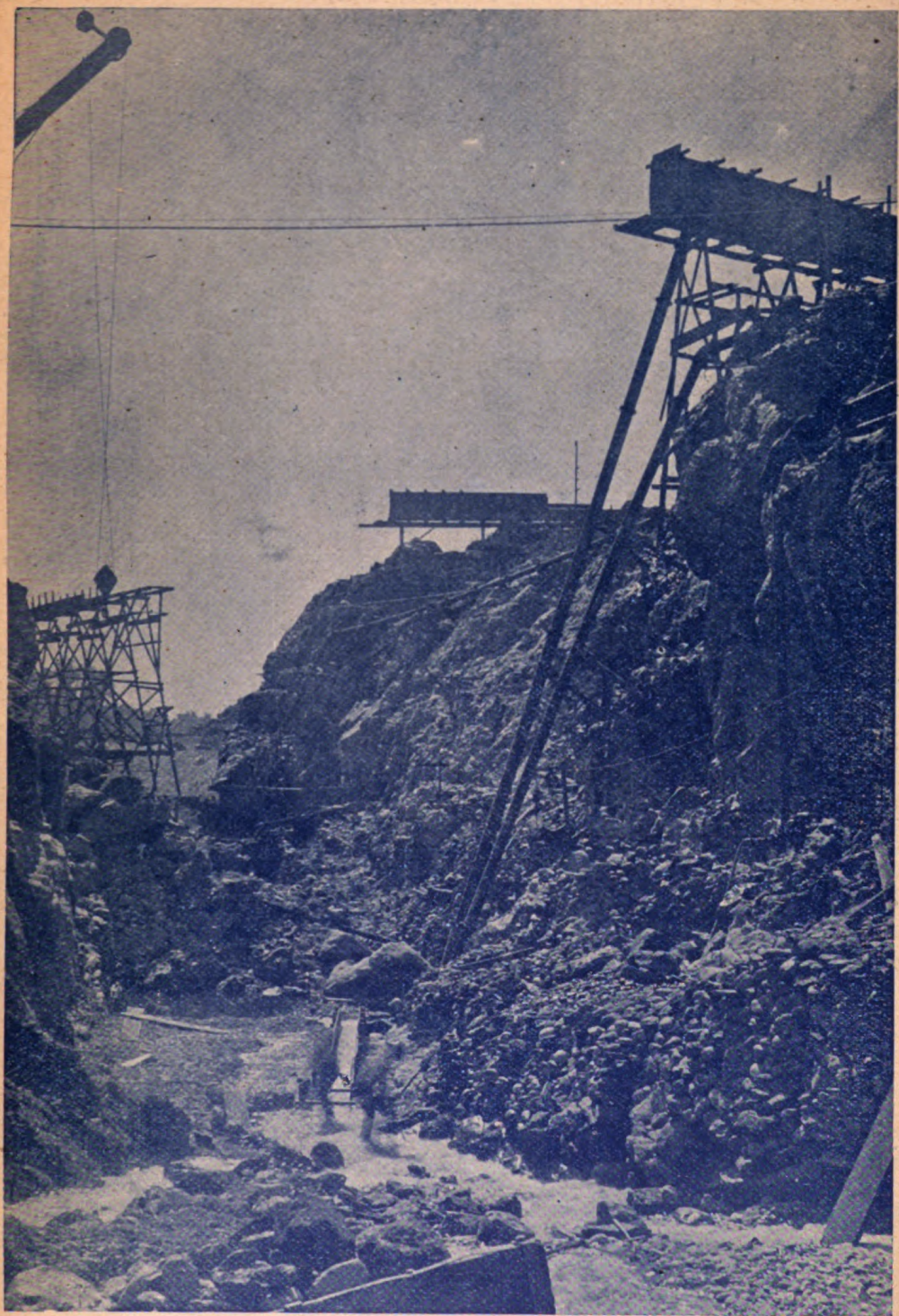


PLATE No. 8

EVANS ELEVATOR LIFTING SEVENTY FEET.

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Working 2000 Cubic Yards Gravel per day from a depth of 45 feet, at a cost of 3 cents per yard.



Gold Dredging on the Yuba River by the Improved "Risdon" Gold Dredge.

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CATALOGUE No. 16

2nd EDITION.

Gold Dredging

Feather River, California

BUILDERS OF

Risdon Water Wheels "Pelton Type"
Improved Bryan Roller Mills
Evans Hydraulic Elevators and
Hydraulic Mining Machinery
Ore Feeders, Rock Breakers
Mining, Pumping and Hoisting Plants

PUBLISHED BY

The Risdon Iron Works

SAN FRANCISCO, CAL.

-1898-

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Terms, Shipments, Etc.

TERMS

Cash on delivery at our works, or one-third cash with order, balance subject to sight draft with bill of lading.

SHIPMENTS

Give full shipping directions with order. State whether preference is to be given to a certain route, and, if so, give the name of railroad, etc.

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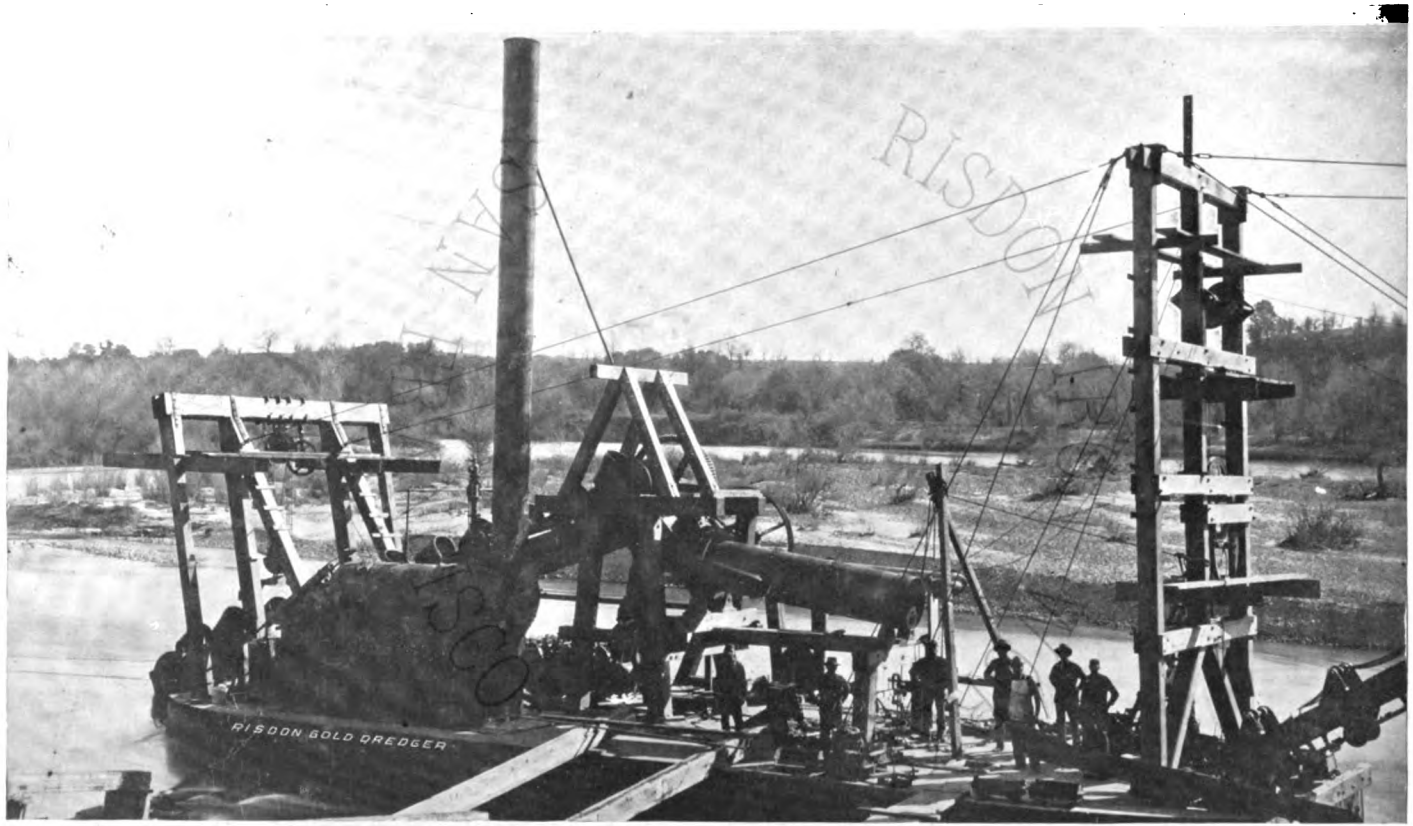
The Following Illustrations are From Views Taken on Feather River and Yuba River.

NOTICE

We beg to notify the mining public that we have purchased the patents and right of building Mr. R. H. Postlethwaite dredges; also the improved form of Gold Tables and Riffles.

We are aware of the claims made by other manufacturers as to their patents. *We infringe none and do not propose that others shall infringe ours.* We shall be glad to quote prices for dredges complete, set up and in running order, on receipt of particulars.

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GOLD DREDGING ON FEATHER RIVER, CALIFORNIA

Handling Gravel at 3 cents per cubic yard

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Gold Dredging in California

Written for the London "*Engineer*"

BY

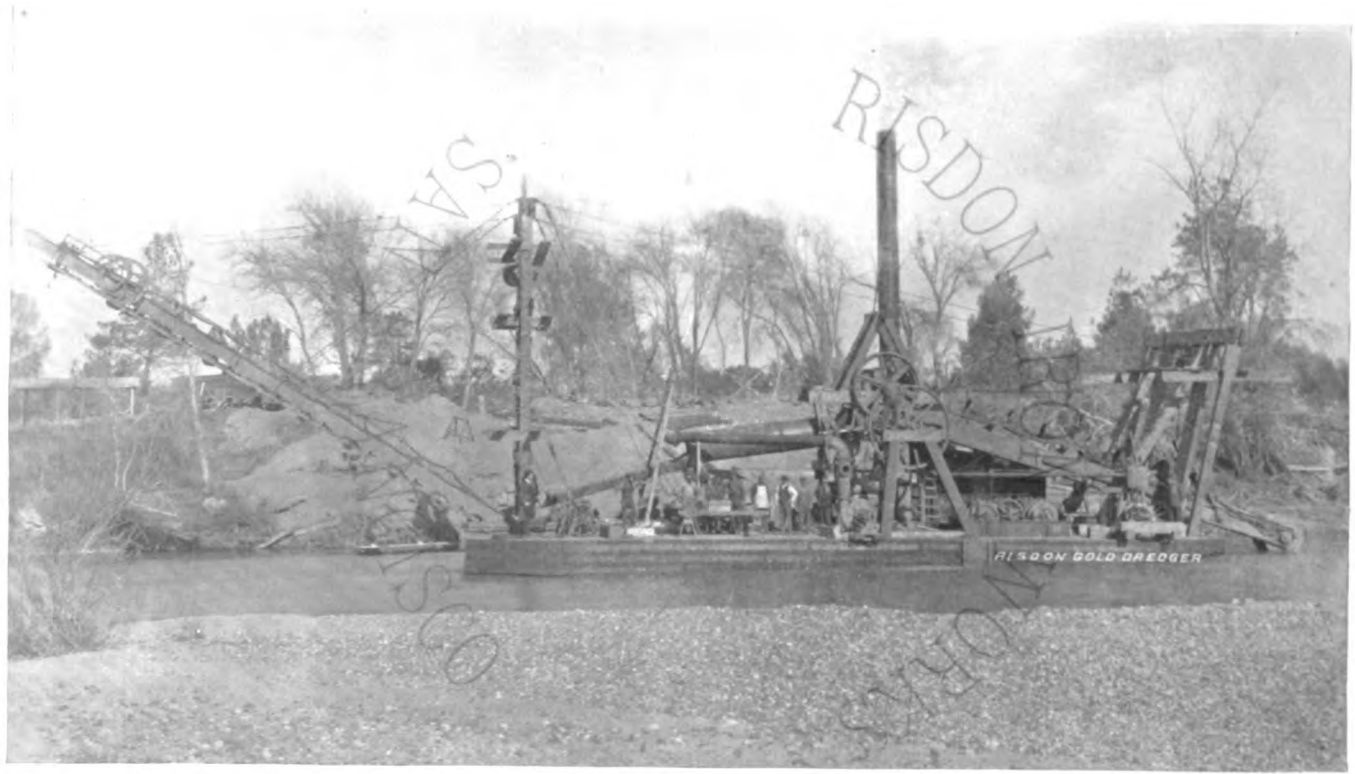
R. H. Postlethwaite, Memb. Inst. Electrical Engineers, England

This industry has recently taken a great stride in its history, which up to the present year has not been a very brilliant one. There have been many attempts at dredging the rivers for gold, but few have been successful, most of the dredges being quite unfitted for the rough work inherent to gold dredging. Those responsible for the design of the machinery did not realize that a dredge capable of doing excellent work in harbor improvement or land reclamation was not fitted to dredge in the rough and rapid streams where the gold is usually found. There have been clam-shell dredges working in our northern rivers for some time, which have been and are yielding good returns; this only shows how rich the rivers must be, as a clam-shell dredge is not the most efficient machine for gold dredging, for two reasons — one being that the bucket cannot be made water-tight, and much of the gold is lost while the bucket is being elevated, and secondly, because it is not easy, even with the best possible arrangement of hopper, to wash and properly treat the material which is dumped into it intermittently in large quantities. For the successful treatment of gravel it is absolutely necessary that it pass over the tables of gold-saving devices in an even and uniform stream, otherwise much of the gold will go overboard again. These various difficulties seem to have been most successfully overcome in a dredge recently designed and built by the Risdon Iron Works of San Francisco. The dredge is of the continuous bucket type, with a very stiff box girder ladder nearly 70 ft. long, carrying thirty-eight buckets, each of 3¼ cubic feet capacity; these buckets are very strong, with heavy spring steel lips, and owing to their peculiar shape, dig into the hardest ground, and seem generally to come up full of heavy boulders, gravel, and bits of broken bedrock. The bucket belt travels at the rate of fifteen buckets per minute, which gives a gross capacity of over 100 cubic yards per hour, which is delivered in an almost continuous stream into

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a perforated revolving screen. This screen is set on a grade, so that the heavy material gradually travels through it and is discharged overboard at the stern of the dredge. A perforated water-pipe extends into the screen, the water at the rate of some 3,000 gallons per minute thoroughly washing the gravel and finding its way with the gold and fine material through the perforations of the screen and into a distributing box; from thence it goes on to the gold-saving tables, which are divided into sections, and are covered with cocoa matting and expanded metal. The excellence of these tables is shown by the class of gold saved on them, much of it being so fine that it can only be seen by the aid of a magnifying glass. The water is supplied by a centrifugal pump, and the whole of the machinery on the dredge is run by a marine engine indicating less than 40 horse-power. The dredge is handled by two men, one a fireman and the other a winchman. It is mainly owing to the excellence of design of the power winch that a dredge with the large capacity of 2500 cubic yards gross per day requires only two men on a shift to operate it. The winch has six barrels, four of these control lines running from the four corners of the dredge, the fifth carries the head line, and the remaining one raises and lowers the ladder. By means of the five working lines it is possible to rapidly make the dredge take up any position. The advantages of this method of operating a dredge, compared to the old method of a "sett" or "spudd," is very marked. When working on a rough bedrock with very large boulders, it is of immense advantage to be able to rapidly shift the point of attack. The spring given by the lines also appears to make bedrock work not only less severe on the machinery, but also more efficient in its results than when the dredge is held solidly by a spud. Those unacquainted with the latest improvements in dredging would be astonished at the bedrock which can be cleaned. Still, there are many rivers where the most enthusiastic dredger will admit that he cannot clean bed-rock properly, but even in these places a dredge has a use, as, by its means, a large hole or paddock can be economically excavated, then pumped out by hydraulic elevator — provided the seapage can be overcome — and cleaned up in the usual manner by shoveling into sluices. Ordinary ground can be handled by this new improved dredge at from 3 cents per cubic yard, and ground can be handled from 60 ft. below the water level to 20 ft above, at a cost which, it is claimed, is less than that of any other known process.

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GOLD DREDGING ON FEATHER RIVER CALIFORNIA

Handling Gravel at 3 cents per cubic yard

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Capacity of Dredges

We have frequent enquiries as to the capacity of our Dredges.

The gross capacity is 2500 cubic yards per day of 24 hours, counting that there is no delay and that the buckets come up full. In practice we find that 2000 yards is about an average and this is what we consider our dredge will handle. We are asked why we do not build larger sizes and will say the capacity is entirely governed by the *space at our disposal for gold saving*, and at 2000 yards we can do better work, make a closer saving and handle our Boat more economically.

If you wish to handle larger quantities buy two or more boats.

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GOLD DREDGING IN CALIFORNIA

Capacity 2,000 cubic yards per day, at a cost of 3 cents per cubic yard.

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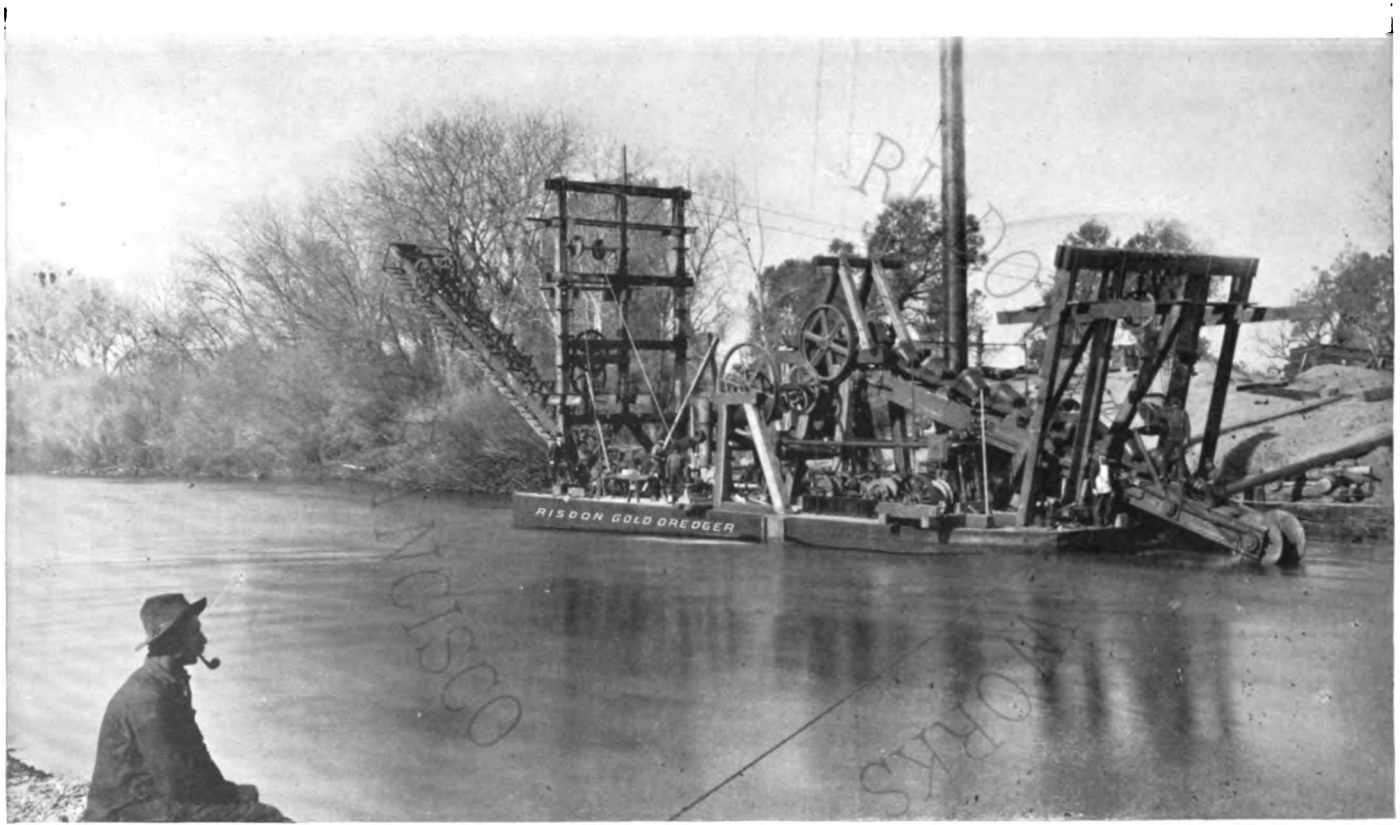
Risdon Gold Saving Tables

Send for Catalogues Nos. 5 and 15 giving information of our Gold Saving Tables and Elevators.

Our Patent Tailings Elevator or Stacker

This appliance makes it possible to work by the dredging process banks that are 20 feet above water line, the elevator carrying the tailings far enough from the stern of the boat to keep the water space clear. The elevator is built of steel I beams which carry a continuous chain of buckets. The I beams are strongly bolted to the hull and are supported at the outer end by stays.

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GOLD DREDGING IN CALIFORNIA

Capacity 2,000 cubic yards per day, at a cost of 3 cents per cubic yard

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GOLD DREDGING ON FEATHER RIVER, CALIFORNIA

Handling Gravel at 3 cents per cubic yard

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SAN FRANCISCO

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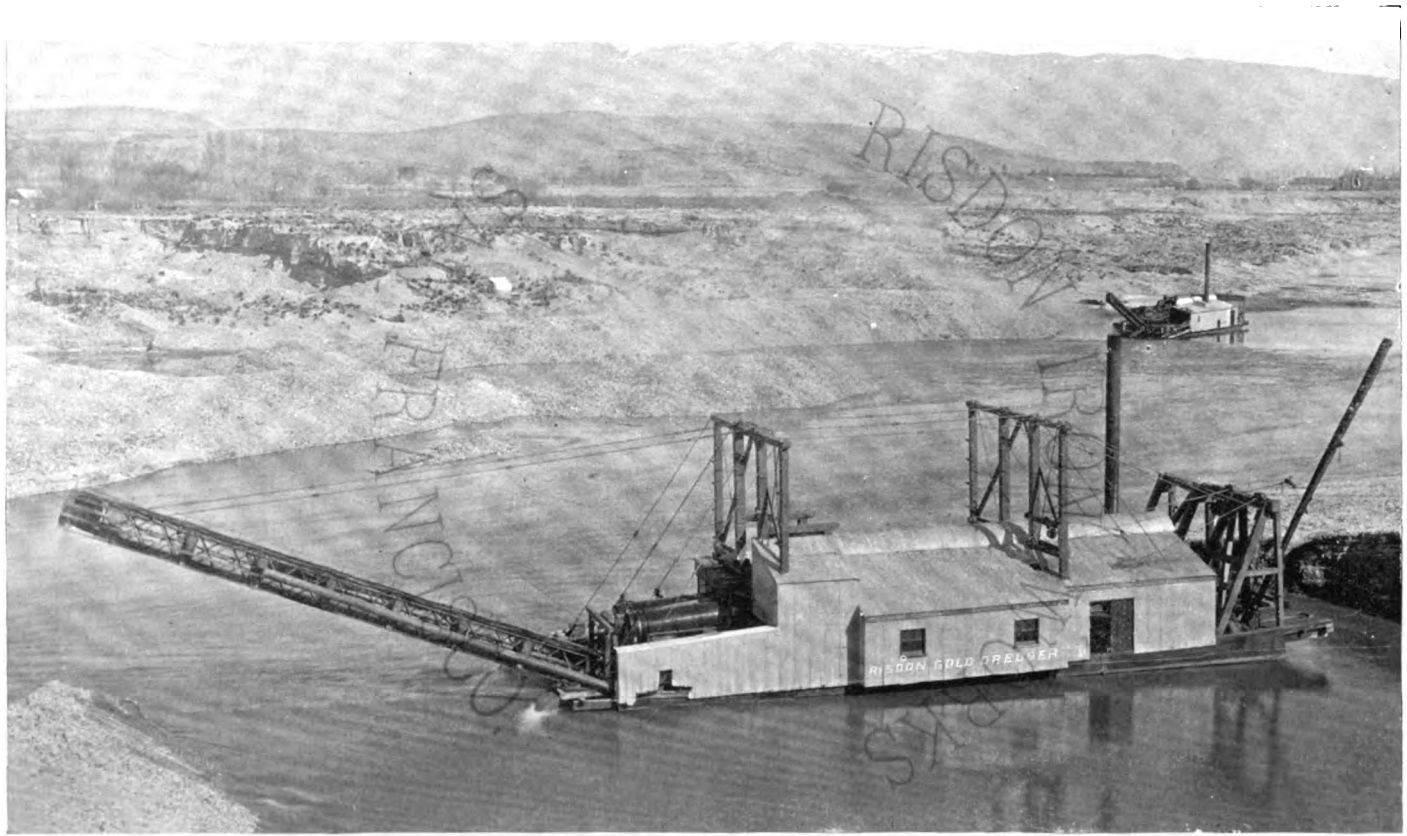
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GOLD DREDGING ON FEATHER RIVER, CALIFORNIA

Handling Gravel at 3 cents per cubic yard

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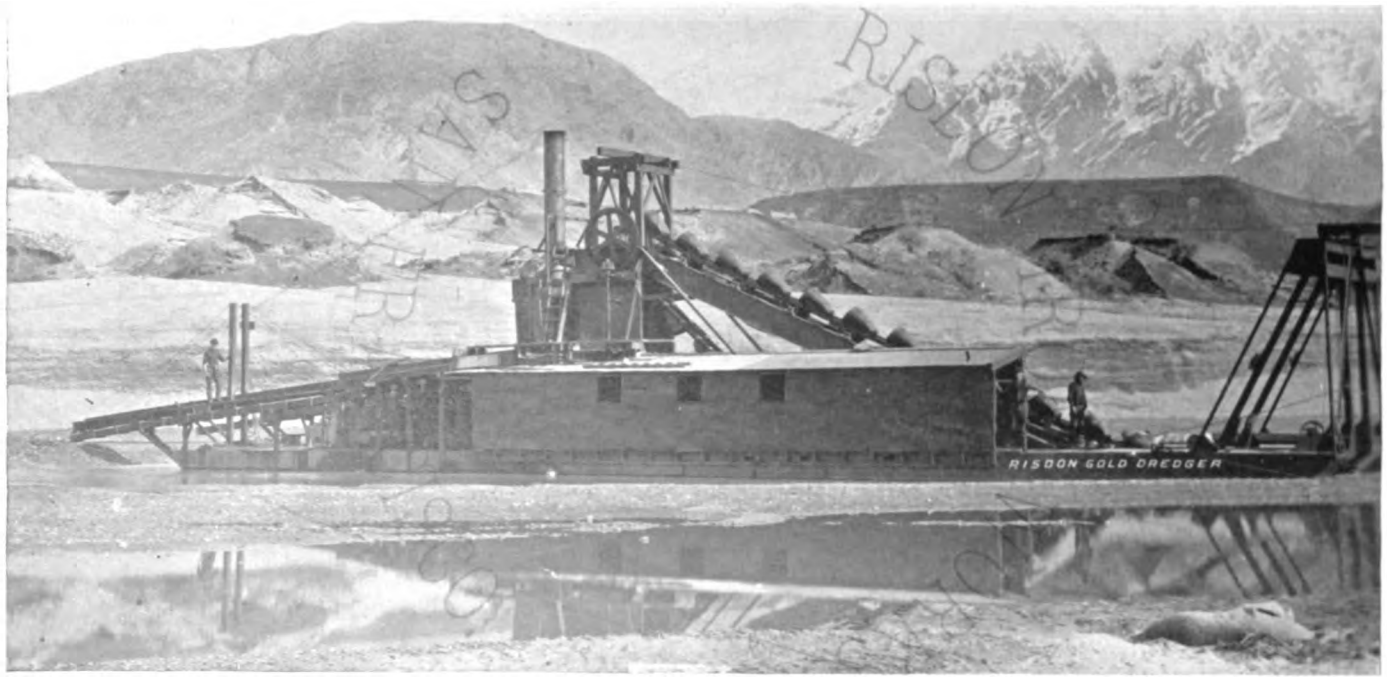


GOLD DREDGING IN CALIFORNIA

Capacity 2,000 cubic yards per day, at a cost of 3 cents per cubic yard

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GOLD DREDGING IN CALIFORNIA.
Handling Gravel at 3 cents per cubic yard

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RISDON IRON WORKS

GOLD DREDGING IN CALIFORNIA

Capacity 2,000 cubic yards per day, at a cost of 3 cents per cubic yard

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GOLD DREDGING IN CALIFORNIA

Handling Gravel at 3 cents per cubic yard.

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For Working Placers When Water Power is Available

In situations where there is not sufficient water to float a dredge, or where the boulders are too large for that system and the water power available, we recommend the Evans' System. (Send for Catalogue No. 5.)

This system will be advantageously used where there is not sufficient grade to carry off tailings from the Giants, and will be found a very useful and economical system.

We illustrate a view of such a plant in operation, on inside back cover.

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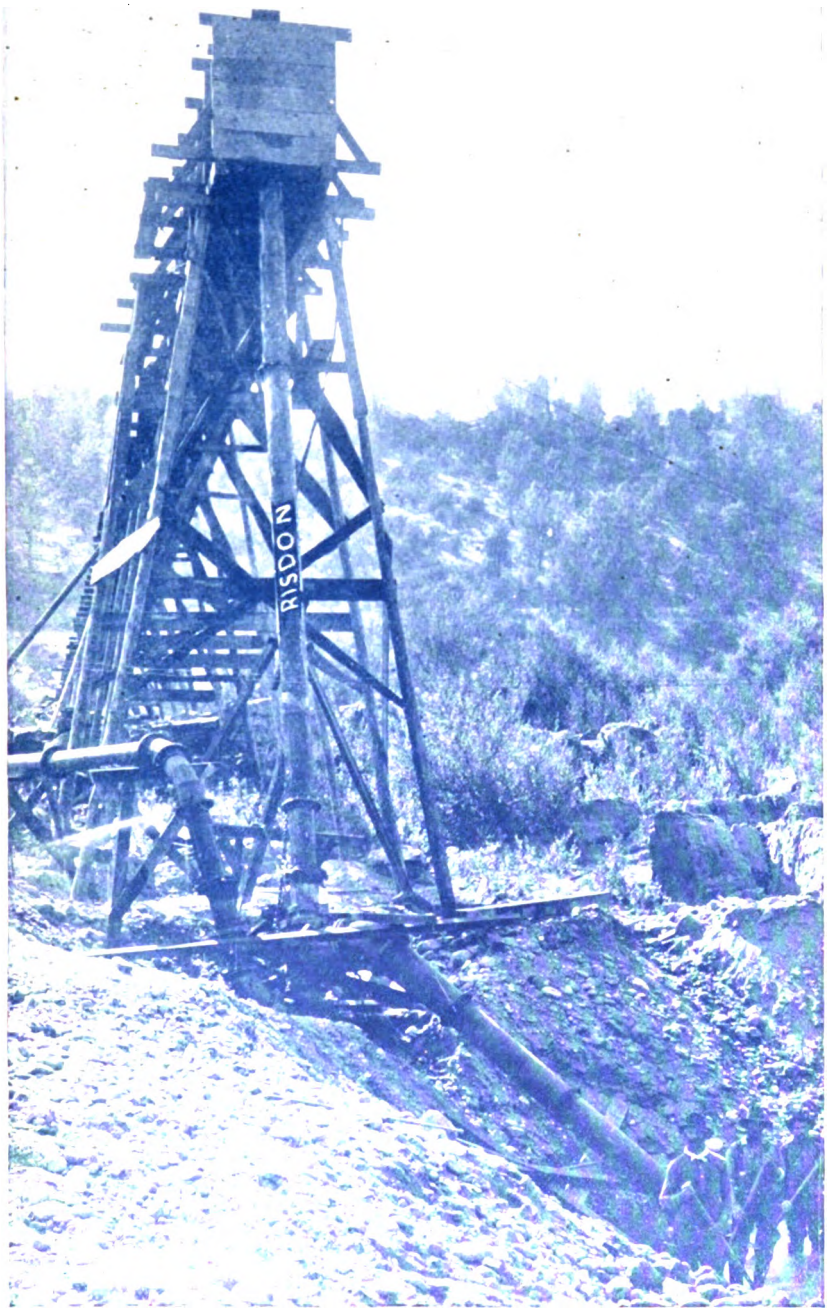
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Owing to the many details to build boat to suit different requirements and prevent failure from lack of knowledge we prefer to build Dredge complete and turn same over in running order.

Our terms are CASH during progress of work.

VULCAN IRON WORKS SAN FRANCISCO

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EVANS ELEVATOR

Lifting 70 feet on Bear River, Head 300 feet, Capacity 2,000 cubic yards per day, 24 hours.

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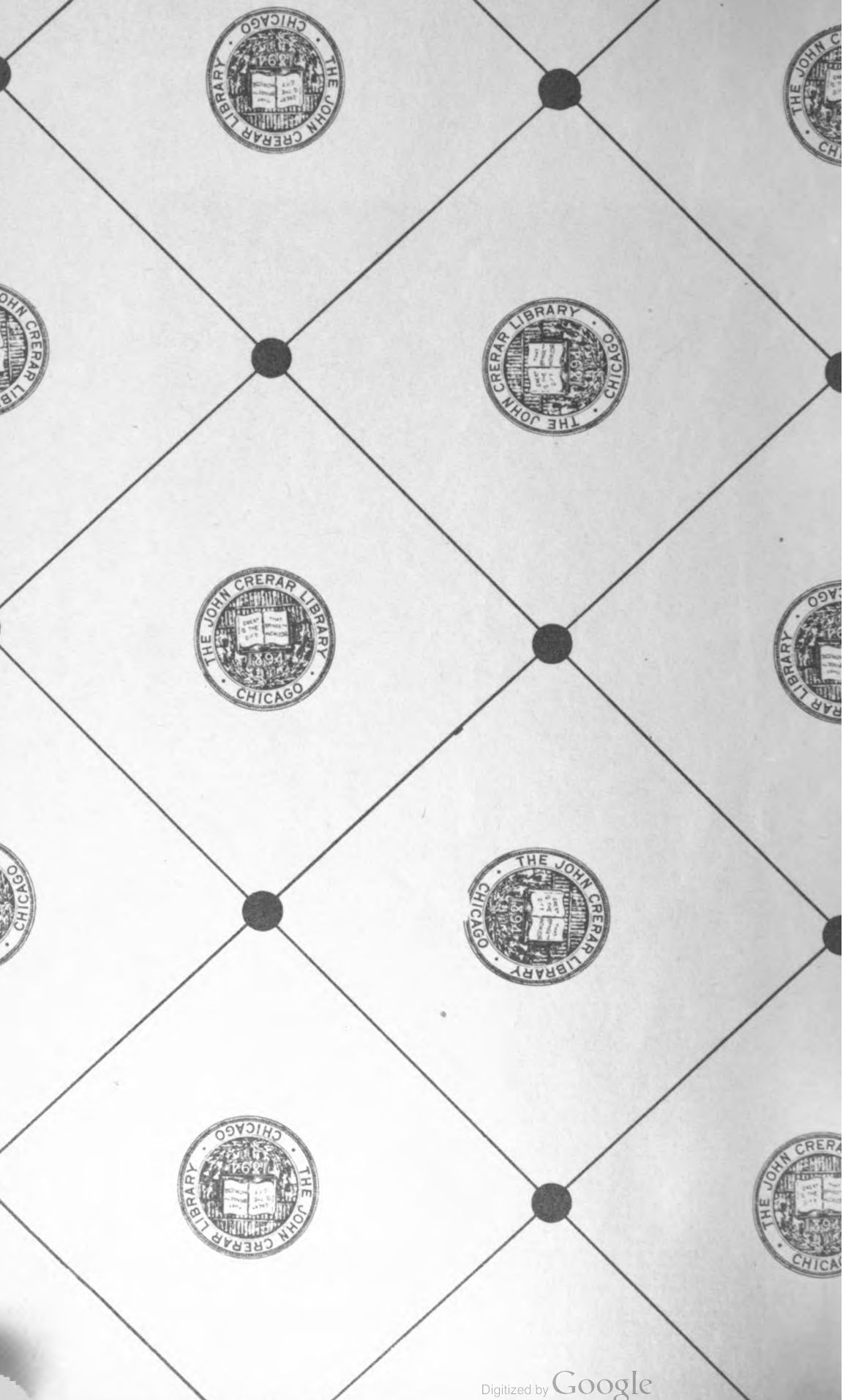
GOLD DREDGING IN CALIFORNIA

Capacity 2,000 cubic yards per day, at a cost of 3 cents per cubic yard.

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